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Leaders Who Have Made a Difference in Deburring

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Abstract
The contributions to burr technology of 55 individuals and two institutions are presented in this paper. It is the only published work known to highlight leaders over the past 65 years in this international effort to reduce the costs of burrs and edge finishing. The most prolific companies for publications and impact include the Institute fur Producktionstechnik Automation (IPA) of Stuttgart, Germany, the Bendix Corporation, the Consortia for Deburring and Edge Finishing (CODEF) at the University of California at Berkeley, and in Russia, The Don State Technical University led by Dr. Anitolie Babichev.

Background

In the mid 1960s and early 1970s burrs were costing US industry 3-5% of total manufacturing part cost. That was an estimated 5-10 billion dollar expense and involved an estimated 300,000 workers in some manner. At that time no publication listed all the known deburring processes, provide comparisons, nor offered any guidance on reducing costs. The author of this paper volunteered assigned to research and find means to reduce the burr related costs to the plant at which he worked. After some work in this area it was clear that a larger focus was needed and he and others began the SME Burr, Edge and Surface Technology (BEST) Division. As a result of that hundreds of papers have been written and dozens of conferences held round the world to focus attention on this subtle issue that is so important to part function.

Where no data existed, empirical information was generated. Burr prevention had no science base – today it has a strong mathematical foundation centered at Berkeley. Automated selection of processes and best practices has been reduced to computer programs for some aspects. The world's literature has been compiled into both bibliographies and books. The world leaders in this field have been identified and meet regularly.

Today the cost of burrs has in general fallen as a result of both technology and the pioneering work of the many people listed in this paper. Deburring still adds cost, but rather than being universally considered a manufacturing ill or result of inadequate processing, it is slowly being recognized as a functional value added process.

The People Who Contributed
Many individuals have made a significant difference in the economics and growth of the deburring and edge finishing technology. One-hundred-nine distinct deburring processes are identified today and each represents a unique opportunity to improve production. In a retrospective review the author highlights his observations of the many individuals who have helped advance the technology and art of burr related issues.

Lost among these names are the hundreds of thousands who have used the tools, finished the parts, and made the assemblies functional through their own craftsmanship. The trainers, the inventors, the users are largely forgotten, despite their contributions. As readers reflect upon the insights offered below, they might wish to add additional thoughts, which the author will find a way to present in other forums. The list is comprehensive, although readers may have differing views and other insights. The thoughts are those of this paper's author who has lived the applications, bought the equipment, wrote the instructions, trained 600 users, and researched both processes and prevention. It is based on his experience and review of over 5000 references and some 20-40,000 pages of information. Most of the works cited are listed in more detail in *Deburring: A 70-Year Bibliography*, prepared by LaRoux Gillespie and Elena Repnikova in 2001.

LaRoux is also preparing for publication a lengthy bibliography of Russian deburring works by Anitoly Babichev (Анатолий Прокофъевич Баьичев).

It is an international list, presented in order of the dates of first burr related publication.

The dates behind each person's name are the dates that the individual is known to have been actively engaged in burr technology. The actual dates may extend beyond these, but they are at least representative.

Federico Strasser 1930-1985

Federico Strasser occupies a unique niche in deburring. As a writer for the metal stamping industry for 55 years he has provided over 2500 articles or shop tips for improving sheet metal operations. Of those an estimated 10 percent (about 250) had something to do with burrs. More specifically they included, how to design parts to minimize burrs, hide burrs so they are aesthetically acceptable, but not require removal, prevent the tearing that occurs because of the stress risers that burrs cause, and putting burrs on the side of the part that does not interfere with next assembly operation,

Mr. Strasser lived in Santiago, Chile but wrote for the world. His first article appeared in 1930 in Italy. While he wrote mostly in English, he also wrote in German, Italian, and Spanish. His first article noted in the US related to burrs was "How Control of Burrs Aids Sheet Metal Stamping" published in *Iron Age*. *Chilton* published *Practical Design of Sheet Metal Stampings* in 1959. His book *Metal Stamping Plant Productivity Handbook* appeared in 1982 published by Industrial Press. SME published his book *Functional Design of Metal Stampings* in 1971.

Leroy Beaver 1946-1956

LeRoy Beaver was the first to write extensively about deburring. His 22 *Products Finishing* magazine articles in the 1946-1956 era provided readers with a wealth of practical information on barrel finishing. The majority of these ran as a series in 1946 and 1947 and truly were definitive for that time.

Herbert Chase 1947-1955

Herbert Chase followed Beaver's writing. He wrote for *Iron Age*, *Metal Finishing* and other magazines. His "Tumbling Nylon Cams" article in 1950 represented the first article dealing with plastics. We have found eight articles by Mr. Chase.

Ezra Blount 1951-79

Ezra Blount only wrote three items on deburring that we have found, but his 1977 and 1979 SME papers provided the first overviews of industry standards for burrs in aerospace companies.

William E. Brandt 1952-73

William Brandt wrote 41 articles in *Automatic Machining*, *Iron Age*, *Machinery*, *Products Finishing* and a variety of smaller magazines. He covered barrel tumbling initially and then in 1959 began extensive works on vibratory finishing. His history of vibratory finishing appeared in a 1967 *American Machinist* article. His topics covered die-castings, powdered metal parts and conventional machined and stamped parts. During his 21-year career he wrote 41 articles and in 1974 he received SME's Progress Award for his extensive work. William Brandt was a Vice President for Park City Chemical Company when he retired and appears to be the first industrial deburring individual to recognize the value of extensive publications as free advertisements that attract readers to deburring companies.

Ralph Enyedy 1955-59

The first book on deburring and edge finishing was Ralph Enyedy's *Barrel Finishing* published by Reinhold Publishing Corporation in 1955. Mr. Enyedy was an Industrial Engineer working for Westinghouse Electric Corporation and his book is filled with hand drawn part illustrations and operation sheets that describe simply how each part was finished. In 19 chapters he covered the basics as well as the specifics for individual parts. This was the single most important work at that time on deburring. It covered

only barrel finishing since vibratory and other related processes had not been invented. It was excellent for its detail and breadth of the issues it covered.

Masahisa Matsunaga 1957-

Masahisa Matsunaga received his first degree from the University of Tokyo in 1941 in Precision Engineering, and his Ph.D. in 1957. He became a professor there in the Institute of Industrial Science. He began his burr-related research with his reports and articles in 1957 and his 1959 book *Barrel Finishing* (written in Japanese). Many of his works have been published in English although the work has been done in Japan. *Finish Deburring Methods* (1959), *Barrel Grinding* (1963) followed. In 1965 his landmark work "Vibratory Finishing – Fundamental Research" was published in *Metal Finishing* and other sources. This outstanding work provided data on metal removal and edge rounding for many positions and media in a vibratory tub. It provided the first detailed understanding of what happens and where in a tub machine. This work was followed in 1966 with "Some Experiments on Centrifugal Barrel Finishing," also in *Metal Finishing*. It too provided a landmark data driven view of centrifugal finishing. In 1967 "Researches on Barrel Finishing" appeared in the University of Tokyo reports. After that he turned to evaluating more effective media, automation in finishing, spindle finishing, and vibratory barrels. For years he worked closely with Hisamine Kobayashi, a deburring equipment pioneer and President of Shiskashima Tipton in Japan. He teamed with Toshiro Ioi in 1985 for work on deburring robots. He still supports deburring work in Japan. He is the eldest of our world's living statesmen in deburring.

Dr. Matsunaga's expertise includes surface phenomena, surface roughness measurements, lapping, electron microscopy and diffraction, Beilby layers, metallurgy, electrical contact resistance, wear, lubrication, solid lubricants, electro-deposition, and RF diode sputtering. His works have been published in the *Review of Scientific Instruments*, the *Scientific Papers of the Institute of Physics and Chemical Research*, SME papers, *International Journal of Production Engineering Research, Bulletin of the Japan Society of Precision Engineering*, *CIRP Annalen*, *Metal Finishing*, *Reports of the Institute of Industrial Science*, and several other Japanese journals.

He has been a leader in Japan's BEST-J association for the promotion of edge finishing technology. That is the current world leader in burr related journal publications.

Dr. Matsunaga's work is scholarly, easy to follow, exhaustive and directly applicable to industrial use. We are aware of 22 of his publications prior to 1978, but believe the number is much higher than that today. For this work he has received awards from the Japan Society of Precision Engineering and the Metal Finishing Society of Japan.

Keiji Okushima 1958

In 1958 Keiji Okushima and Katsundo Hitomi published "The Side Flow of Metal in Machining" and in 1959 continued with "Part II- In the Case of Three-dimensional Cutting." This appears to be the first work looking at the mechanics of burr formation in metal cutting. Because it was written for the *Journal of the Society for Precision Mechanics of Japan* in Japanese it remained out of the view of most if not all U.S. researchers and burr workers. A 1944 paper of unknown authorship appeared in Seitsu Kikai, vol 11, No. 9, pp. 25- 33 which provided an empirical view of burrs produced under two drilling conditions.

Hisamine Kobayashi 1959-

Hisamine Koabayashi is a world leader in deburring, although most in the US have not heard his name. He is the holder of over 500 Japanese and American patents for a wide variety of tumbling processes. He began Shiskashima Tipton in 1959 a firm that is now a leader in Japan in metal finishing equipment technology.

His machines include reciprofinishing machines, spindle finishing, vibratory, barrel and centrifugal and centrifugal disc machines. Most include extensive automation to meet the Japanese market.
He was author or co-author of several technical papers particularly in the 1970s. Many of his works were co-authored with his good friend Masahisa Matsunaga. He initiated the *Tipton Technology News* publication and wrote for that also. He was Chairman of the Japan Barrel Finishing Conference from 1973

to 1980. And has held training courses every year from 1972 to 1985 at the request of the Japan International Cooperation Agency. He was a consultant to the US's BEST Division of SME and of Japan's BEST-J. He was Chairman of Nagoya's South Rotary Club from 1983-1984.

His inventions have been prominently displayed at Japan's invention Fair since 1959 and received awards every time including the Prize of the Director General of the Science and Technology Agency. His vibratory finishing equipment received Medals for distinguished invention in 1973. In 1980 he received the third order of merit from Emperor Hirohito for his distinguished services for Barrel Finishing. In1985 his invention of vibratory finishing processes and equipment was selected as one of the most valuable 53 inventions in Japan as part of the 100-year celebration of the Japanese Industrial Proprietorship System.

His culminating mark of excellence is the 1985 Tipton Mechantro Barrel Pavilion better known in the west as the first flexible finishing system (FFS). This system, the Tipton Mechatro-Barrel Center, is a computerized process selection system and plant that automatically selects the best mass finishing process and associated processing details, then enters the parts into the system. It includes spindle finishing, centrifugal barrel centrifugal disc, vibratory, electrochemical, chemical, blasting, waste treatment equipment, automated feed and material handling robots. Described in SME paper MR85-830, this is the first application of flexible machining system technology to metal finishing operations.

L.D. Tarasov 1959

L.D. Tarasov was the first U.S. individual to explore and define the impact of mass finishing on part service life. In this instance he described the increase in life that was obtained when barrel tumbling parts that would be under significant stresses in service.

William P. Nunn 1961-64

William Nunn wrote a series of barrel finishing articles in several magazines, but most notably in *Precision Metal Molding* in the 1961-1964 era.

Bernard Hignett 1964-1986

Bernard Hignett was one of the leaders of SME's Burr and Surface Technology Division from its inception until a skiing accident about 1986. Bernie's delightful English accent and unflagging promotion of centrifugal barrel finishing processes made him a popular speaker at deburring conferences. He wrote 32 papers or articles that we know of while working for Harper Buffing Machine Company, but others may have appeared in a variety of smaller trade journals. His 1976 SME paper "A Comparative Media Evaluation" was the first open paper providing data on media effects in this process.

Anatoly P. Babichev 1964-

Dr. Anatoly P. Babichev (Анатолий Прокофъевич Баьичев) is a world leader in research on vibration and its use in manufacturing. LaRoux first learned of Dr. Babichev 35 years ago when he began his research on deburring. As he read the Russian literature Babichev's name consistently appeared. He is still active. He is probably the foremost authority in the field of vibratory technology in the world.

Anatoly Prokofievitch Babichev has the titles of: Professor of the "Machine Construction Technologies" Department of Don State Technical University (Rostov-on-Don, Russia), Science chief of the "Vibro-techology" Department, Chairman of the "New Technologies" Society, Chairman of the "Vibro-technology" Council, Founder and Chairman of the seminar on "Using Low-frequency Oscillations in Technologies", Doctor of Technical Sciences, Correspondence Member of Technology Sciences of the Academy of Russia, and Member of the "High Technologies of Machine and Instrument Building, Constructional Materials and Power-saving" Council.

Dr. Babichev started his work in 1943 as a turner in a railroad yard; graduated from an aviation technical school in 1949; graduated from a mechanical faculty of polytechnical institute in 1954; graduated from a

physical-mathematical faculty of teacher's institute in 1953. From 1949 to 1961 he worked in an aircraft plant as a designer, master, head of design bureau and head of a shop. From 1961 Dr. Babichev worked in the Scientific Research Institute of Technology of Machine Building; from 1968 he has worked at the Don State Technical University (DSTU) as a department head, professor, and head of the "Vibro-technology" Laboratory.

Anatoly Prokofievitch Babichev is the founder and the leader of the scientific branch of "Vibration Technologies", the founder of the "Vibrotechnology" scientific school, the author and developer of the scientific program of "Vibrotechnology". The theoretical and experimental researches of Dr. Babichev and his team of post-graduates and employees have developed the theoretical basics of finishing methods based on using low-frequency oscillations. Under his leadership they developed processing methods combining the physical effects of magnetic, heat, electrical fields and chemical reactions with vibratory processing.

His practical implementation of scientific research developed new processes and better understanding of existing processes. He applied these findings in industry and developed improved vibrational equipment for finishing precision details and surfaces. These are used today to produce high quality surfaces, remove burrs and smooth edges. Vibratory impact strengthening and stabilizing processing are used throughout the world today. Combining vibro-processing with physical effects of electrical, magnetic, acoustic, heat fields, chemical reaction energy resulted in new methods. Combining mechanical and chemical processes improved finishing and coating. His work includes more than 300 scientific papers and 11 monographs. He has received 95 authors' certificates, which indicate that he is the author of this exceptional number of inventions.

Dr. Babichev manages post-graduate courses and doctorate courses. Fifty students have prepared theses and received their candidate degrees. Three received their doctorate degrees under his management.

He is a designer of and an analyzer of vibratory finishing mechanics. That includes machine design as well as action in the vibratory tubs. Dr. Yuri Baron another Russian deburring leader is one of Dr. Babichev's former students.

What is not as obvious is that his work includes every vibration aspect, from product vibration to stress relieving, from metallurgy and atomic spacing to burr reduction. He literally addresses every bit of vibration technology. Most of his publications deal with the processes that you and I face in production. While he clearly is able to address all the theoretical aspects, he also is a man who knows the practical side. His breadth encompasses both sides of the track.

Dr. Babichev is truly a research leader, a practitioner, a designer, an inventor, a teacher, a scholar, and a recognized expert. While his work is generally not known in the West because it is all in Russian, he is the epitome of research in manufacturing engineering and clearly the leader in all Russian technology in this field.

Dr. Babichev's son also is a contributor to this technology so some publications will have two Babichev authors.

John B. Kittredge 1965-1994

John Kittredge is the leading U.S. author of vibratory finishing technology. He appeared in print first with "Fluorochemical Surfactants Control Diverse Corrosion Problems," in *Materials Protection* in 1965. Vibratory finishing of diecastings was his next topic, followed by a wide variety including Roto-Finish's ice bonded vibratory machine. His extensive knowledge in vibratory finishing is most clearly elucidated in his 1977 SME paper "The Testing of Vibratory Finishing Media." This was based on years of his experience at Roto-Finish and provide the first public look at many simple yet subtle issues for users to evaluate their own equipment operations. He followed that with papers in 1979 on calculating the number of parts that can be effectively finished per cycle, effective use of steel media, future trends, the mathematics of mass finishing and a series of articles covering the entire field in *Products Finishing* magazine. In addition to his many practical hints and insights into the chemical issues of compounds, it is

his work on quantitizing the economics and operation of vibratory and other mass finishing processes that stands out as his legacy. He put simple equations and calculational techniques in front of the job shop user so the user could know what his real costs were as well as how to improve them. He also was the first developer of a computer program to help select appropriate operating conditions and proper equipment capacity. While John has retired from the metal finishing business he still resides in Kalamazoo, Michigan.

Gary V. Robbins 1966

Gary Robbins, a college classmate of LaRoux Gillespie, initiated the first data driven studies seen by the author of this paper with his work on edge radii produced by a variety of media and several different machines. The miniature parts that needed finishing had tolerances of less than 0.003 inch for many edge radii and no manufacturer and no publication provided any numerical facts of process capability when Gary started his work in the mid 1960s. Gary worked for the Bendix Corporation in Kansas City and his work was published in a company report in 1966. He turned his deburring research over to LaRoux Gillespie in 1966 and that began LaRoux' on-going effort in burr technology. Gary provided 120 charts showing what happened to edges for stainless steel, aluminum and other materials in variety of media and machines.

Peter Arzt 1967

Peter Artz, an aerospace engineer, was one of the first to note that the strain-hardening coefficient played an important role in determining how big burrs would be. His empirical information and thoughts on this aspect appeared in the 1967 article, " Why Burrs Form – and How to Avoid Them." While his work did not describe the mechanics that caused the relationship, his observations were important as a general clue to how to minimize burrs as well as providing initial insight that contributed to including strain hardening as part of LaRoux' research on burr formation mechanics.

Bruno Siegel 1968-1978

Bruno Siegel is Germany's answer to dedicated work in a specific technology of deburring. Mr. Siegel began his work with publications in electrolytic deburring with a 1968 article in *Mitt. Deutsch Forschungsgesell Bleachverarb*. He wrote 22 articles through 1978, the most eye catching of which was his SME paper "How to Deburr 1,000,000 Drill Holes within 15 Minutes." His work covered both electropolishing as well as electrochemical deburring, although electropolishing seemed to be his strength.

Akiyasu Yuki 1968-1973

Akiyasu Yuki was the first researcher to explore the formation of burrs in drilling. The first of his three 1968 papers was entitled, "A Study on Burr in Drilling," published in the *Research Bulletin of the Faculty of Education* (Gita University Natural Sciences). As co-author he is found in other papers with Shigeo Zaima describing the drilling of aluminum.

Yuzo Saito 1970

In 1970 Yuzi Saito, Kinji Sato, Tsuneo Saga, Magoto Ogawa and Shozo Mizusawa added to the information on drilling burrs with their paper "Drilling Machinability for Aluminum Sheets" in *," J. Japan Inst. Light Metals (KEI Kin Zoku.).* Three articles of similar direction were published by this team that year.

Khalil Taraman 1970

Khalil Taraman with advisors S.M. Wu, and K.K. Wang made a major contribution with their 1970 ASME paper, "An Analysis of Punching Variables by Two-Level Fractional Factorial Design." The contribution was of three forms. First while SME and other organizations had published excellent papers from the 1940s through the 1950s on the impact of punching variables, this is the first that described how the variables affected burrs in any detail. Perhaps the most important aspect of this paper is it was the first to use Statistical Design of Experiments for burr related research. The University of Wisconsin was a world leader in applying this tool, which was originally developed for use with agriculture. This approach allows researchers to cut hundreds of tests down to 10 or 20 and gain the same insight. LaRoux picked it up here with other SME papers by Dr. Marvin DeVries to form the basis of his approach to burr and other metal cutting research. This is still the premier work on punching variable impact on burrs. Its last contribution was the observation that multiple measurements on the same piece is necessary to gain any reliability on burr size changes. In other words the knowledge that 25 measurements might be necessary for each hole or

surface to characterize burr dimensions was a new thought. Dr. Taraman went on to advise Tony Sofronas on a an important Ph.D. study of drilling burrs. Sammy Wu is a legend for his research and leadership in manufacturing at the University of Wisconsin and K.K. Wang also became a leader in many metal cutting efforts.

R.S. Adams 1970

R.S. Adams provides in-depth insight with his 1970 paper in *Rubber World* on the "Economics of LIN Deflashing." LIN in this instance is Liquid Nitrogen. This is the first of only two or three articles written yet that provide a view of the cost and operational needs of cryogenic deflashing. His 1969 paper in *Cryogenics and Industrial Gases*, was entitled, "Deflashing Molded Rubber Parts with Liquid Nitrogen."

PERA 1970

The Production Engineering Research Association (Melton Mowbray, Leicestershire) in 1970 published a series of reports on deburring equipment and technology in England. The editors or leaders are not known today, but these works illustrated many tools used. The association appears to have been a multi-year consortia that completed its work and dissolved. It was not recognized or known in the U.S., although the author of this paper did manage to get a copy of one of the reports, "Guide to De-Burring of Machined Components, Part IV- Power Tools." This was the first serious effort to provide users with a broad view of processes available and their details.

Charles R. Rhoades 1970

Charles Rhoades wrote a 1970 SME paper that described the new Extrude Hone process. This was a new process, and the U.S. was ready for new ways to cut the cost and problems of deburring. The 1970s were the heyday for advances and communications in this field. As an example the first magazine article about this process brought 5000 inquires. A typical magazine article today brings 5 or 10 responses although new equipment reply cards may bring much more.

The process added greatly to provide faster finishing of parts having many holes or cutouts, but the approach used was as interesting as the process and its application. Mr. Rhoades was the owner of a machine shop and knew the problems of deburring and finishing. He was an entrepreneur as well. He had the vision that a viscous material could be forced through the part to remove burrs. He worked for months trying to find a material that would do all he wanted. He ended up with a thixatropic rheopectic material new to the market at that time. The public called it Silly Putty, which was a silicone-based material. Before he found silly putty however in one of his experiments he had a troop of Boy Scouts chew massive amounts of chewing gum that he would later use as the burr removal material. Extrude Hone became a legend. Mr. Rhoades continued to run the firm for a few years and gradually turned control over to his son Larry Rhoades who established a name in the industry as well.

Lawrence (Larry) Rhoades 1970-

Larry Rhoades, another of SME's Burr, Edge and Surface Technology Division leaders led the Extrude Hone Corporation through major growth in the industry. In the 1970s and 1980s he built Extrude Hone on the uniqueness and successfulness of its "Silly Putty" process. The aerospace industry desperately needed small smooth air holes and burr free edges to keep product life up. As the conventional process became well known he supported research at the University of Nebraska that led to several adaptations of the process. Today in addition to the basic process, Extrude Hone markets orbital, stream and ultrasonic assist variations. Other adaptations also sprouted from the basic process tree. Mr. Rhoades also brought a capacitive surface roughness-measuring tool to market to work with his deburring and surface finishing equipment. In the 1990s he expanded Extrude Hone by acquiring electrochemical and thermal deburring processes. Today Extrude Hone is a major leader in deburring processes.

Mr. Rhoades was also one who capitalized on the observation that every presentation to a professional audience was another means to market ideas and the company name, so he volunteered often to speak and lead conferences, and quickly became a household name in the industry. It was not unusual to see his name on 5 or 10 publications a year, each one adding a bit of new knowledge on the Extrude Hone process.

Mr. Rhoades rose in the SME hierarchy also to lead its machining efforts and much of its technology interests. He become an industry leader outside SME for metal removal and machine tools. Larry is clearly a strong market oriented leader as well as visionary of what might be. In his pursuit of an MBA he became an authority on Howard Hughes' life and business acumen and Larry capitalized on some of those bits of knowledge. His support for the Consortia for Deburring and Edge Finishing (CODEF) at the University of California at Berkeley is another example of taking deburring beyond just industrial existing practice by means of keeping abreast and leading research into the next level. He seemingly has one foot in practice, one foot in business and one foot in advanced technology.

Larry's contributions as implied above include taking an idea and expanding it to become an expert on one aspect of burr technology, making the BEST Division a resounding success as one of its leaders, and consolidating nonconventional deburring companies into a multi-source center for users so they can obtain comparative insights at a single setting. As a result of his many years leading deburring efforts he became an expert on many processes beyond his own

LaRoux K. Gillespie 1970-2004

One of LaRoux' first assignments at the Kansas City Bendix plant in the 1966 era was to finish a vibratory deburring research project begun by previous Kansas University graduate Gary Robbins. Since LaRoux was in the midst of finishing his Masters degree in Mechanical Engineering at KU he naturally began reading the literature on deburring and found nothing substantial so he dug deeper and soon it was clear that any data on deburring would be new information. He extended Robbin's vibratory work, which in itself was the first data driven information the author had found. From vibratory finishing he watched another Bendix engineer Bob Hishaw work some magic with cryogenic vibratory finishing of plastic parts.

LaRoux was assigned to precision miniature part manufacturing. Many parts were so small they were lost beneath the fingernails. If they fell on the floor many were lost because they could never be found. The tolerances were often in the range of +/_0.0002 inch and some were +/- 0.000050 inch. While he had responsibility to manufacture the parts for 15 years LaRoux had research projects to make it easier to deburr the minute parts. He developed a nine-month training program for 100 new workers to deburr under 30X magnification. He trained 600 machinists to rough deburr the same parts. In the midst of that effort it was clear that deburring was a multi million-dollar expense and that more comprehensive knowledge was needed. In 1972 after analyzing all the known processes and publishing his findings through his company, he received one of the first Bendix Fellowships and returned to school to develop theories of how burrs form. He finished his Master's degree in Manufacturing Engineering at Utah State University in six months. His thesis, *The Formation and Properties of Machining Burrs* was the first formal publication of the theoretical mechanics of burr formation.

In 1974 Bill Spurgone of the Bendix Research Lab noted the work in Kansas City and asked LaRoux to partner with Nad Ajlouny on an SME paper describing all the known deburring processes. By that time LaRoux had published 27 other reports and articles (largely Bendix reports), but his two papers in 1974 were the first that had wide public visibility.

An SME member since his college days, in 1975 LaRoux convinced SME that conferences on deburring were needed and he along with many others began an SME group known as the BEST division (Burr, Edge and Surface Technology). He invited Dr. Masahisa Matsunaga and others to present the Japanese works in this area at the 1975 conference in Chicago and in a hotel room LaRoux presented many of his thoughts on deburring to the Japanese delegation. Koya Takazawa was one of the audience who would become the Japanese leader of deburring renown. LaRoux began pumping out 10 SME reports a year as well as many through his company.

As it became clear that deburring was a field needing more attention LaRoux decided he wanted to know everything known about burrs and deburring so he studied some German and Russian and began looking at foreign works. He now holds about 20,000 pages of deburring articles, catalogs and reports in multiple languages. Despite intense effort it is apparent that he will never find all the known burr related knowledge, but he has captured lots of it. For 15 years LaRoux was both researcher and the person who implemented

the improvements in his plant. He had one hand in research and one in application. He learned as much from the operators as he did in his research.

What are his principle contributions to this field? He has six burr related books published with a seventh one ready for publishing. 130 of his 180 publications are burr related. He compiled all the known literature into convenient bibliographies. His latest such endeavor lists 4500 references on burrs. All his works are based on data and statistical methods. His research and application include works on drilling burrs, milling burrs, grinding burrs, reaming burrs, sheet metal burrs, ball broaching burrs, deburring effectiveness, deburring costs, brush deburring, centrifugal barrel deburring, vibratory deburring, extrude hone deburring, manual deburring, electrochemical deburring, robotic deburring, process control, the measurement of burrs, inspection for burrs, rational approaches to attacking burrs, burr standards, training for deburring, and burr minimization and prevention. He has documented hundreds of practical working tips or better ways to do the work, and summarized the leading areas of knowledge in many compilations for ready access by the public.

His books include: *Deburring Capabilities and Limitations,* SME (1976), *Advances in Deburring,* SME (1978), *Deburring Technology for Improved Manufacturing, SME (*1981), *Robotic Deburring Handbook*, SME (1987*), Guide to Deburring, Deflashing and Trimming Equipment, Supplies and Services*, Deburring Technology International, (1996 and 2000), *Deburring and Edge Finishing Handbook*, SME (1999), *Deburring: A 70 Year Bibliography*, Deburring Technology International, (2001), *Hand Deburring: Increasing Shop Productivity*, SME (2003), and his last work which is in progress is *Mass Finishing Handbook*.

LaRoux has received 26 local, national or international awards for his work. Among them are ASME's Arthur L. Williston Medal and Award, SME's Award of Merit, SME's Albert M. Sargent Progress Award, and BEST-J's Award of Merit. He is listed in *Engineers of Distinction* and other reference works. He is a member of ASME, SME and has been active in many other professional groups in his career. He has held 58 positions in SME alone, including Director at three different times. He is a Fellow of SME and a long time contributor to the University of Kansas Mechanical Engineering Department and the School of Engineering. While he is not an academic, his Curriculum Vitae is 38 pages long.

LaRoux enjoys fishing, writing, motivational speaking, genealogy, and developing young engineers.

Robert M. Kramer 1971-1974

Robert Kramer is the owner of Kramer Industries, Inc. in Coppiage, NY. His publishing career includes a 1971-1974 series in *Precision Metal* discussing barrel and vibratory finishing. These provided some practical hints that had not appeared elsewhere. His company designs and sells both kinds of finishing equipment.

Manfried Dreher 1974-1980

Manfried Dreher appears in print in a 1974 issue of *Galvanotechnik* with his article, "Progress and Development Trends in Metal Finishing with Barrels, Vibrators and Centrifugal Polishing Equipment." He follows that in a few years with a series of four others also written in German.

Dreher mass finishing equipment was well known in Germany in 1975 and has been for the years since that time.

Koya Takazawa 1974-

Dr. Koya Takazawa first tackled burr technology in 1972, when he worked in Toshiba's Production Technology Research Laboratory. This work involved developing the idea of machining precision accuracy design and development of some deburring and edge finishing machines for rotary compressor parts used in room air conditioners. Barrel finishing of vane valves used on exported machines was one of his first deburring assignments. In 1975 he established Toshiba's Deburring Committee. After this he began many other burr and edge technology issues. He was Manager of Toshiba's Precision Machining Center.

After moving to the Kanagawa Institute of Industrial Technology from Toshiba Company in the 1980's he performed basic research on burr problems to solve many questions correlated with Toshiba's work. Dr. Takazawa's works are all industrially related. He began his research career at Kanazawa University and served there for 23 year, after receiving his Ph.D. from Tohoku University for research on the heat affected zone from grinding. After retiring from the university in 1995, he began his own company Cest la Vie Technical Laboratory in Kamakura City, Japan.

His books include, *Burr Technology* published in Japanese by Asakura Company in 1980, *Burr Formation and Contro*l published by Nikkei Technical Publishers in 1982 (Management Center (1981)), a Collection of Surface Finishing Techniques by Nikkei Technical Publishers in 1983, (Nikkei Gijyutso Tosyo (1984)), *Ultraprecision Machining Burr Technology* by the Japan Society of Abrasive Machining (1984*), Accuracy Design and Parts Finishing System Technology* by Nikkei Technical Publishers in 1985 (Nikkei Gijutsu Tosyo (1989)), the *Complete Book of Shop Production* by Nikkei Gijyutsu Tosyo (1992), 52 reports and articles by 1997 and a series of videos on burr technology by the Business & Technology Division of Nikkan Kogyo Newspaper. All of the above books are in Japanese.

His contributions include work on barrel finishing, burr and edge standards, magnetic abrasive deburring, burr formation, drilling burrs, brush deburring, brush wear compensation, secondary burrs, ultrasonic deburring, robotic deburring, spindle finishing, expert systems for burr technology, burr prevention, He has received awards for his burr related work from the Society of Abrasive Machining (1976) for his work on deburring machines for precision parts, the Foundation for Promotion of Machine Tool Technology (1987) for work on magnetic abrasive finishing, SME awarded him the Award of Merit in 1987 and their Gold Medal and Award in 1997 for his leadership and work in this field.

Dr. Takazawa came to Chicago in the late 1970s to attend SME's first Burr, Edge and Surface Technology Division (BEST) Finishing conference on deburring. When he saw the widespread possibilities and support in the US he returned to Japan and in 1980 organized a sister association to do the same there. As a result he his compatriots began BEST-J ("J" for Japan), which for 20 years has been the leading publisher of edge related articles and research. BEST-J publishes a "slick cover" journal with the best of technology in any language. Dr. Takazawa is the General Director for Execution of BEST-J.

As the leader of BEST-J and a leader in the Worldwide Burr Technology Committee (WBTC) he has taken the promotion of burr technology to Russia, China, Korea, Germany, and Taiwan by establishing centers of similar interest in each of those countries. He led International conferences in Japan in 1990, China in 1992, Korea in 1994 and Germany in 1996. He has been an important behind the scenes leader and supporter for the US conference in 1998, and Russia in 2000.

For the past 30 years burrs have been a passion and an obsession with him. He is dedicated to both the study of burrs and the promotion of burr technology. Dr. Takazawa consults with the world's leading companies on burr technology and travels internationally several items a year to explore and solve burr-related problems. His enthusiasm, commitment and promotional efforts are legendary, and a unique hallmark of his excellence and success. He has been the first person to advocate that surface and edge finishing should be viewed as key elements in the theory of machine accuracy design.

His contributions go far beyond deburring and edge finishing. He has performed grinding research, contributed to theories of designing for accuracy, nonmetallics, surface integrity, surface roughness, tribology, noise analysis and control. He holds one patent, is a long time member, and past Chairman of Tokyo's SME chapter, Honorary Member of the Japan Society of Precision Engineering, a Life Member of the Japan Society of Mechanical Engineering, and a Japan representative of the WBTC. He is licensed as a technical consultant in Japan, and speaks Chinese, Japanese, English, Russian, and German. He entertains as a magician, is a voracious reader, and is an expert charcoal and watercolor artist. He also holds a grade in Japanese fencing, and plays tennis, Ping-Pong and loves traveling.

Koya Takazawa is clearly one of the legends in international burr technology – a researcher, consultant, teacher, manager, promoter, international leader, student, - a man who makes things happen.

Institute fur Producktionstechnik Automation (IPA) 1974-1995

The IPA of Stuttgart University has been an International leader for understanding burr-related issues for three decades (1970-1990s). Ph.D. students have studied many edge and burr related issues during that time. Among the most notable was Friedrich Schäfer, who is discussed below. Hans-Jürgen Warnecke was a leading professor supporting the research and Dr. Hans U. Brauner of Robert Bosch also was a driver in this milestone work. The research eventually covered most common industrial forms of deburring as well as burr minimization and prevention. IPA displayed the result of their work to industry in German conferences as well as two SME papers and many of those observations are now incorporated in the world literature of this technology (i.e. it is no longer thought of as just German contributions). Many electrolytic finishing advances can be traced to this group. Other individuals related to this effort included T. Wagner and H.J Warnecke.

Neil Weightman 1974-2004

For almost 25 years Neil Weightman has led deburring discussions on microblasting of burrs. Neil was one of the SME BEST Division participants and is President of Comco in California. Neil continues to write articles and innovate improvements for conventional applications as well as for clean room use. He is the leader today in describing micro blasting technology.

Hans J. Warnecke 1974-1986

Dr. Warnecke appears many times in the 1970s on thermo-chemical finishing issues. He too is one of the IPA disciples, and as such all his work employs quantitative data. His 1974 *Industrie-Anzeiger* article was entitled, " Thermische-Chemisches Entgraten- Entgratqualitat." In 1979 he appears as a book author on industrial robots (Krausskppf) and he continued with robotic deburring efforts after that.

Yuri M. Baron 1975-2004

Professor Baron is another of today's world leaders in deburring. He is the Russian spokesman for the Worldwide Burr Technology Committee and an expert in magnetic abrasive finishing. Dr. Baron as noted above was a student of Dr. Anatoley Babichev. In 1975 we find one of his articles on magnetic abrasive finishing summarized in *Manufacturing Engineering* while the actual article was published in *Mashinostroyeniye* (in Russian).

While the Japanese knew of his research and work in this area, because of the language differences and difficulty of obtaining Russian magazines, he is largely unknown in the U.S. In 1986 he wrote a 186-page book on this topic and it clearly is the first book on this topic. We do not have a full citation for Dr. Baron's accomplishments, but he is a leading citizen in the edge finishing community and is still active in his area of expertise. He chaired the 2000 WBTC Conference in St. Petersburg, Russia on deburring.

Friedrich Schäfer 1975-1977

As cited above Dr. Friedrich Schäfer became one of the world's leading authority on deburring with his work at IPA and his 1975 book *Entgraten* (Deburring). It was the first book on deburring that covered all the essential processes as well as burr formation and prevention. While the book provides excellent summaries of the deburring processes, it is the quantitative work on burr formation and minimization that make this work stand apart. His Ph.D. dissertation at the University of Stuttgart was entitled, *Untersuchungen zur Gratbildung und Zum Entgraten insbesondere beim Umfangßtirnfrasen*. Dr. Schäfer was the first to illustrate the major effect of the angle at which the tool leaves the part and the included part angle has on burr size. He followed that up with articles in German magazines and two 1977 SME papers that made his work available to the U.S. audience. His pioneering work set the stage for Gillespie and Dornfeld and others to study and proselytize the impact of edge angles and cutting angles.

Anthony (Tony) Sofronas 1975-79

Anthony Sofronas was a Ph.D. student under Dr. Khalil Taramon, who is mention above for sheet metal burr work. Tony was also an employee of the Bendix Corporation's Detroit Research Center. In 1975 he published within Bendix his "The Formation and Control Drilling Burrs." Later he described his work in SME papers and in his dissertation. Using statistical design of experiments he studied the effect of system stiffness, workpiece hardness and spindle speed on drilling for half-inch diameter holes. The simplicity of

his work set a standard for others to follow and his observation that system stiffness, preventing the drill from surging through the metal reduces burr size were his major contributions.

In 1977 he reported in a Bendix report simplified vibratory finishing approaches that were useful to industry.

Thomas B. Wagner 1975-79

T. Wagner was another of the IPA researchers who tackled deburring. His first publication was in 1976 with "Entscheidung Stabellen Zur Losung von Entgrat Problemen." He followed with a 1976 SME paper, "Computer Aided Machining – A Solution for Deburring Problems."

Klaus Zerweck 1975-1977

Klaus Zerweck wrote most often about electrochemical deburring. He appears first in IPA proceedings in 1975 with "Elektrochemisches Entgraten in Badanlagen." In 1977 his SME paper was entitled, "Optimizing Process Parameters in Electropolish Deburring."

Tom Drozda 1977

Tom Drozda wrote a major article on deburring technology in his 1977 *Production* magazine article, "Deburring – The Common Cold of Industry." This was a multi-page spread that included data and the first magazine complete spread of issues and state of the art. It was a hallmark for excellence and in-depth reporting for deburring.

Jerome F. Miller 1977-1983

Jerome (Jerry) Miller was one of the first U.S. authors to publicize electrochemical deburring technology. He was another of SME's BEST Division participants. His papers were designed for the average reader and showed in detail how fixturing should be designed for best effect. Dynetics purchased Jerry's Chemtool Company in the late 1980s and Extrude Hone purchased Dynetics in turn in the late 1990s.

T. Shinmura 1980-2004

Dr. Shinmura, a researcher at Utsonomiya University in Japan, is the world's leading researcher and innovator on magnetic abrasive finishing. Dr. Shinmura has published 43 major papers on an entire industry. In addition to conventional abrasive magnetic finishing of cylindrical shapes, he has developed new designs to finish spheres, shared in work on internal pipe finishing, and designed equipment for at least seven different families of machines. His work is of the highest technical quality, yet simple enough for most users to understand the essentials of his findings. His work allows users today to finish parts to submicron finishes with edge breaks controlled down to 0.001 inch, while removing minute amounts of stock consistently. Dr. Shinmura's first work on this topic appeared in 1980, following some of the Bulgarian and Russian work. In addition to bringing forth a process that holds demanding tolerances and surface roughness, Dr. Shinmura's contribution clearly has been to develop processes to the extent that they can be used commercially.

Dr. Shinmura's work has been published around the world, although his research is all in Japan. His protegee is Hitomi Yamaguchi who has established her own portion of the work.

Toshihiro Ioi 1980-2004

Toshihiro Ioi, known as Mr. One-oh-one (number 101) to his friends because of his name, is another of the broad based researcher and application engineers from Japan. Dr. Ioi's first English paper was a 1981 SME paper entitled, "Computer Aided Selection of Deburring Methods." This work was co-authored with Hisamine Kobayashi and Masahisa Matsunaga and was a forerunner of Kobayashi's Flexible Finishing System. Dr. Ioi's specialty is industrial economics and related solutions to industry problems. This was the first published paper to explore automated selection of deburring processes based on hard data. It covered multiple processes, but was most closely tied to mass finishing needs for its first application. In 1985 he published "Simulation Model for a Flexible Finishing System." In 1995 he wrote "Expert Computer System for Barrel Finishing."

Subsequent works included robotic sensors for detecting burr size, surface finish visual evaluation, and 3-Dimensional visual display of microburrs and processes suited for plated parts. He is one of the active members of BEST-J, a contributor to the WBTC conferences, and is frequently found visiting the U.S.

Dr. Ioi's major contributions revolve around the computer selection of appropriate processes.

Dr. Naoharu Kinoshita 1981-2002

Naoharu Kinoshita is largely unknown in the west, but he was one of the leaders of BEST-J until his death two years ago. He was one of the behind the scenes leaders, and an adviser as well. One of his best technical works (in the mind of this author) was a study of splinters formed from drilling in wood (not published in U.S.). His unique approach captured the writer of this paper's attention as imaginative and expanded burr technology to wood technology.

Kazuaki Iwata 1982

Kazuaki Iwata's paper, "Study of Mechanism of Burr Formation in Cutting Based on Direct SEM Observation," was the first to use the SEM as a movie source for close up viewing. Mr. Iwata had two co-authors including Kanji Ueda and Koichi Okuda for this *Journal of Japan Society of Precision Engineering*. Copies of his work can also be found in *Journal of BEST-J,* Vol2, No. 1 1982. Dr. Sung-Kim Ko would later do related work at Berkeley.

Dr. David A. Dornfeld 1984-2000

Dr. Dornfield is Professor of Manufacturing Engineering, Department of Mechanical Engineering, (Associate Dean for Interdisciplinary Studies in the College of Engineering) at the University of California at Berkeley, California.

Dr. Dornfeld has raised the mathematical and physical understanding of burr formation to the highest levels. He and his Consortium for Deburring and Edge Finishing (CODEF) have explored the mechanisms by which burrs form and are minimized by using Ph.D. level mathematics and mechanics. In addition to the analytical tools he and his many graduate students have taken many scanning electron microscope photos and videos to substantiate their predictions and understanding. By the mid 1990's Dr. Dornfeld became the world's leading researcher in the field of burr formation and minimization. His consortia has funded several projects including those that explicitly predict how to minimize burrs and how to route cutting tools to most economically minimize deburring.

Dr. Dornfeld began publishing research specifically on deburring in 1987 with his and T. Masaki's paper, "Acoustic Emission Feedback for Deburring Automation." (Acoustic emission is another area of Dr. Dornfeld's expertise.) In 1989 he and Dr. Sung-Lim Ko published, "Analysis and Modeling of Burr Formation and Breakout in Metal." That was a defining work for modern research on how burrs form, and the beginning for many related subsequent research papers. In 1994 he and R. Narayanaswami published "Design and Process Planning Strategies for Burr Minimization and Deburring." That was the first of many papers and works dedicated to planning strategies for the manufacturing engineer.

By the year 2001 Dr. Dornfeld had published more than 60 publications explicitly on burrs and deburring. Others of his 269 publications also dealt with burrs. His work covers turning, drilling, milling, prevention, prediction, minimization, planning, CAD, databases, and deburring. He is one of the world's only authorities on laser deburring. He is the world's leading authority on burr minimization as well as formation. He leads the world's foremost research facility for burr related information. He is recognized worldwide and has traveled the world several times speaking and consulting with leaders in the field of deburring and related technologies.

He is the holder of five patents.

Dr. Dornfeld has many honors and awards including three distinguished educator awards, ASME's Blackall Machine Tool and Gage Award, and SME's Outstanding Young Manufacturing Engineer's Award. He is

active in ASME, SME, American Society of Precision Engineering, Acoustic Emission Working Group, Japan Society of Precision Engineering, CIRP, and the Japan Society of Mechanical Engineering International Journal. He has been a Director of SME and member or leader of many committees of several of these groups. He was President of the North American Manufacturing Research Institution in 1990. He is a Fellow of SME and of ASME. His Curriculum Vitae is almost 20 pages long. He is one of the two US members of the Worldwide Burr Technology Committee, a group of international leaders in deburring and edge finishing.

H. Kazerooni 1987-1991

H. Kazaerooni, currently professor at the University of California at Berkeley was a leader in robotic deburring work from 1987 to 1991. His interest centered on control theories for this challenging use of robots. The mid 1980s was a bonanza for robotic work, but few recognized the difficulty of tracing complex edges accurately. Special control algorithms were needed to even produce commercial quality edges.

R.J. Stango 1988-1999

Robert Stango is king among brush deburring researchers. In 1988 he began a lengthy career exploring the mechanics of what makes brushes effective deburring and finishing tools. The 1988 ASME Conference Proceedings includes, " Analysis of Constrained Filament Deformation and Stiffness Properties of Brushes." Over several years from Marquette University he provided industry with mathematical insights into brush performance. He is still answering questions on this area of deburring.

Hans-Michael Beier 1988-2004

Hans-Michael Beier appears in German patents in 1988 for his deburring cutters. He next began a broader role in deburring with his "Theory and Practice of Deburring." "Trends in Deburring Technology was next in a 1990 *Werkstattstechnik* article. Robotic deburring articles and others appeared each year for the next decade. His 146 page book *Industrielles Entgraten: Theorie, Praxis, Probleme, Lösungen* was published in 1990 by Verlag Technik Berlin. Dr. Beier participates in most of the WBTC conferences to represent German knowledge and experience. His book briefly covers most of the deburring processes and some burr minimization issues.

Sung-Lim Ko 1989-2004

Sung-Lim Ko is one of the first graduates of Berkeley's Consortia for Deburring and Edge Finishing (CODEF). His Ph.D. dissertation entitled "Burr Formation and Fracture Mechanism at the Exit Stage of Machining" was published in 1989. ASME also published a slightly different tittle the same year. He continued his work with a 1994 publication of similar title published by the WBTC at the 4th International Conference on Precision Finishing and Burr Technology in Korea and the 5th International Conference in Germany in 1996. For the 1998 conference Dr. Ko prepared another classic entitled, "Measurement Technology for Micro Burrs." In 2000 he presented "Development of Burr Measurement System Using Laser and Its Application."

Koichi Kitajima 1990-2004

Koichi Kitajima, Teruaki Miyake and Yamoto wrote, "Study on Mechanism and Similarity of Burr Formation in Face Milling and Drilling" in 1990. In 1993 Mr. Kitajima was reporting on brush finishing of stainless steel pipe. In 1996 he moved to dry centrifugal barrel finishing and in 2000 for the WBTC conference in Russia he was researching mirror-like polishing of dies using blasting methods.

Alfred P. Thilow 1992

Dr. Alfred P. Thilow, Helmut Prüller, Klaus Przyklenk, Friedrich Schäfer and Siegfried Pießlinger-Schweiger wrote *Entgrat-Technik: Entwicklungsstand und Problemlösungen* in 1992 under the Expert Verlag series by Kontakt & Studium. This 236-page book is an excellent summary of a variety of processes with an emphasis on chemical related ones. The DIN standard for edge definition is presented as well as a few thoughts about issues faced by users.

Michael Massarsky 1993-2003

Dr. Michael Massarsky brought the process known as Turbo-Abrasive Finishing to the U.S. from Russia in 1993. He is the leading promoter of that process in the U.S., assisted by David A. Davidson. The process was first developed and used in Russia and still has developers and users of it there.

Steve Marcus 1992-2004

Steve Marcus is a leader at the Markee Corporation in Columbus, Ohio. He has written a series of articles in *Products Finishing* magazine about mass finishing. Steve has years of practical experience as both a job shop and as a problem solver for media and other mass finishing issues and he offers several practical tips for both new and experienced users.

Ikuya Ohsima 1993

In 1993, Ikuya Ohsima, Katsuhiro Maekawa and Ryoji Murata wrote the article, "Burr Formation and Deburring in Drilling Cross Holes" in the *Journal of Japan Society of Precision Engineering*. This provided useful information for assessing the impact of drilling variables on cross hole burrs. Julie Stein later would publish an in-depth study on a similar topic.

Hidehiko Takeyama 1993

Hidehiko Takeyama, Shunji Kato, Shoichi Ishiwata and Hiroyuki Takeji in 1993 published Study on Oscillatory Drilling Aiming at Prevention of Burr in the *Journal of Japan Society of Precision Engineering*. This provides in depth insight into yet another means of reducing the size of burrs from drilling.

Julie M. Stein 1995-

Julie Stein finished her Ph.D. at Berkeley in 1995 and published an excellent work on burrs formed by drilling. Her first chapter describes the work of most of the previous researchers in this area, and the rest of the work is dedicated to quantitative data on the effects of many cutting conditions on stainless steel when using small drills. Her photos of edges are excellent and provide a standard for describing the different types of drill produced burrs. Julie provided consulting for several years on this topic and lives in the Berkeley area assisting with CODEF. This is one of the few books on small hole drilling that is devoted to burrs. Most other reports describe work with drills of ½ inch diameter.

Kazuya Ohmori 1996-2003

Kazuya Ohmori, before retiring from Iwata Denko in Japan spent several years helping define potential standards for edge definitions. His works appeared in the WBTC Proceedings for several years as well as several Japanese proceedings. He joins LaRoux Gillespie as one of the leaders striving to make major strides in definitions.

Hitomi Yamaguchi 1997-2004

Hitomi Yamaguchi is a research associate at Utsunomiya University in Japan working with Dr. Takeo Shinmura. By the end of 1999 she was the author or co-author of 29 papers most of which were related to magnetic abrasive finishing. Many aspects of her work extended to other finishing issues, but were based in application initially to the magnetic processes.

From 1995 to the end of 1999 she had written or was co-author of 29 reports related in some manner to magnetic abrasive finishing. She also has 43 other papers in other conference proceedings. "A New Internal Finishing Process of Non-ferromagnetic Tubing by the Application of a Magnetic Field – The Development of a Unit Type Finishing Apparatus using Permanent Magnets" was her first paper in this arena. Her work includes impact of heat treatment on the magnetic properties of metals and films, finishing pressures, magnetic fields in general, impact of roundness and cylindricity, finishing silicon nitride ceramics, cutting ceramics and brittle materials, light scattering issues in surface measurement, electrochemical dressing of superhard grinding wheels, and surface integrity issues.

She and Dr. Shinmura are the world's most prolific researchers in magnetic abrasive finishing. Her work on internal surfaces focuses on mirror finishing technology for internal pipe surfaces which transport high-purity gas and water used in the manufacture of semiconductor devices, medical equipment, and nuclear power equipment. These pipes typically require mirror finishes as fine as 0.2 μm Ry or less, a finish that cannot be attained by conventional manufacturing means. Her work allows stainless steel tubes of many sizes and a variety of bends to be polished to this degree. The same work allows hollow cylinders and closed end containers to be similarly polished. Her work includes equipment design issues, operational needs, and measurement of such surfaces and in general fully characterizing the process.

She received her Bachelor, Masters and Ph.D. in Mechanical Engineering from Utsunomiya University, the later in 1996. In 1990 she received an A.S degree from Snow College in Utah. She worked as a research Fellow of the Japan Society for the Promotion of Science from 1994-1996, a Research Associate at the Institute of Industrial Science at the University of Tokyo in 1996-1997 and as a researcher at Extrude Hone Corporation in 1997 and 1998. She is a member of SME, ASME, the Japan Society for Precision Engineering, Japan Society of Mechanical Engineers, North American Manufacturing Research Institution, and the Japan Society of Grinding Engineers. She has received the Japan Society of Mechanical Engineer's Outstanding Young Engineer's Award and SME's Outstanding Young Manufacturing Engineer Award as well as awards for most outstanding papers. She has presented many papers and lectures in both Japan and the U.S., and is active in paper reviews and conference leadership.

Petr Hofman 1999

Petr Hofman completed his Ph.D. at the Czech. Technological University on the topic of burrs formed from grinding. He has written at least two additional articles on that topic.

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