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TECHNICAL REPORT

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INDEX TERMS

Burrs

Deburring

Standards

Design

DEBURRING: AN ANNOTATED BIBLIOGRAPHY VOLUME VI

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ABSTRACT

An annotated summary of 138 articles and publications on burrs, burr prevention and deburring. Thirty-seven deburring processes are listed. Entries cited include English, Russian, French, Japanese, and German language articles. Entries are indexed by deburring processes, author, and language. Indexes also indicate which references discuss equipment and tooling, how to use a process, economics, burr properties, and how to design to minimize burr problems. Research studies are identified as are the materials deburred.

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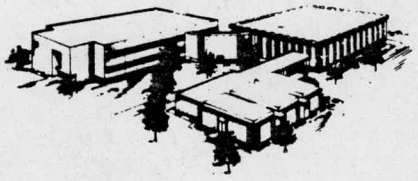

Creative Manufacturing Engineering Programs

ABSTRACT

An annotated summary of 138 articles and publications on burrs, burr prevention and deburring. Thirty-seven deburring processes are listed. Entries cited include English, Russian, French, Japanese, and German language articles. Entries are indexed by deburring processes, author, and language. Indexes also indicate which references discuss equipment and tooling, how to use a process, economics, burr properties, and how to design to minimize burr problems. Research studies are identified as are the materials deburred.

When Eli Whitney originated the concept of mass production, he generated the problem of mass deburring. Today burr and flash removal costs U.S. industry an estimated two billion dollars a year. Despite this high price, industry in general treats deburring as a necessary evil and relies on "art" and tradition rather than science to eliminate it.

The following bibliography is an extension of Deburring: An Annotated Bibliography, Volumes I through V, which were published the years 1974-1978 by the Society of Manufacturing Engineers. This report represents another of several attempts to make burr removal* as reliable and predictable a science as metal cutting is. The information contained in the references cited will provide the reader with an understanding of burr formation and properties, mechanics of each deburring process and a general comparison between the capabilities of each process.

The references listed in this bibliography describe one or more of the 37 principal deburring or deflashing processes, the equipment or tooling used, how to use a process, the economics involved, the formation of burrs, or measures taken to prevent burrs. As such, this report covers both burrs and deburring. Many of the deburring processes are also frequently used to improve surface finish, clean, and descale. Only those articles which are directly related to deburring, which contain the words "burr" or "deburring" in the title, or which present significant related data are included in this paper. While many articles discuss more than just deburring, the annotated comments in this bibliography essentially describe only the deburring aspects of each article.

A special effort has been made to include articles which define edge standards or edge related effects, since they are directly related to the deburring processes.

The references shown were unearthed in a search of the following documents. The words in parentheses indicate the topics searched in each index.

Engineering Index, 1978; January-June, 1979 (metal finishing)

Applied Science and Technology Index, July, 1978 - June, 1979 (metal finishing)

Metals Abstracts, 1978, January-February, 1979 (deburring, burrs, finishing)

Metal Finishing Abstracts, Vol. 20; 21 (No. 1-2) (finishing, burrs, deburring, vibratory finishing, mechanical treatments)

Scientific Technical and Aerospace Reports, 1978 (burrs, deburring, surface finishing, metal finishing)

*For brevity, burrs as implied in this introduction include flash, dross, and allied protrusions. Deburring includes the removal of all these conditions.

International Aerospace Abstracts, 1978 (burrs, deburring, metal finishing)

Rubber Bibliography, 1972 (deflashing, finishing)

Internationale Biblographie der Zeifschriften Literatur, 1978, Part 1 (grat, entgraten)

Government Reports Annual Index, 1977, 1978 (burrs, deburring, metal finishing)

Standard U.S. abbreviations are used throughout this bibliography. The following is believed to be a complete listing of these abbreviations.

ASME - American Society of Mechanical Engineers
NTIS - National Technical Information Service
R.Z.M. - Referativnyi Zhurnal-Tekhnologiia Mashinostroeniia
SAE - Society of Automotive Engineers
SME - Society of Manufacturing Engineers

Most of the foreign language articles have not been annotated because a translation was not available. Similarly, few of these entries are included in the indexes at the end of the bibliography.

Copies of 50% of the English language articles listed in this bibliography can be obtained from the library listed below. Probably 50% of the Russian, German, French and Japanese articles are also available from the same source. Repositories of the remaining citations can be identified by the librarians at Linda Hall Library. NTIS reports can be ordered from the address listed below.

Linda Hall Library
5100 Cherry
Kansas City, Missouri 64141

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

The author is indebted to the librarians and staff of Linda Hall Library for their assistance in retrieving the hundreds of magazines which were reviewed. Their courteous and friendly assistance in deciphering some of the requests is gratefully appreciated.

While a conscientious effort was made to include all entries related to burrs and deburring, some significant articles may have been inadvertently overlooked. The author would appreciate notification of any additional publications on the subject of burrs and deburring which do not appear in Volumes I through V of this bibliography.

FORMAT OF BIBLIOGRAPHY

The entries in this bibliography are divided into six major and 37 subheading deburring categories, two categories on burrs, one on designing to minimize burr problems, and one category entitled "Unclassified". Within each of these categories, entries are listed by year of publication, subsequent sub-divisions and alphabetically by author, then title. Articles by anonymous authors are listed before any of known authors. Patents are described if no other published information was available.

The deburring entries listed in the table of contents are for the most part fairly widely accepted and known deburring processes. Barrel tumbling was also once known as barrelling, rattling and tubbing. Harperizing and spindle finishing have also been called gyro finishing. The terms electropolish deburring and electrochemical deburring are used interchangeably by some authors although there is a distinct difference in equipment, tooling and side effects produced. The reader is urged to review articles listed in these last two categories carefully to prevent confusion. Liquid hone deburring involves forcing water and abrasive over burr laden edges. It is a gentle process which does not rely on blasting or impact pressures. The "burr properties" category includes all references which describe such burr properties as length, thickness, shape or hardness. "Burr Prevention" lists articles which describe how to prevent burrs. In general, most of these articles actually describe methods of minimizing burrs. The "Unclassified" category lists articles which were not reviewed or which do not fit in the other classifications.

Each article is indexed by several classifications in addition to those listed above. These indexes, located at the end of this publication, indicate which articles describe equipment and tooling, present formal research results, describe how to use a process, list the workpiece material, present data, or include some economic analysis. Indexes by author and publication language are also included.

The format used in this issue of the bibliography is similar to that used in Volumes III, IV and V of this bibliography. The processes have been grouped into basic categories of type of removal process. Because of this reformatting process, "H" in this volume and Volume IV is not the same as process "H" in Volumes I or II.

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Electrochemical Processes

BURRS

MISCELLANEOUS

INDEXES

ABRASIVE JET

1973

A1. "Deflashing Expenses Reduced", Plastics Design & Processing, July, 1973, p. 12.

Blasting machine removes flash from general purpose and glass filled phenolic. Blasting eliminated the problem of nicking gold plated leads. Over 20,000 parts are deflashed each day.

1978

A2. "Good Finishing Starts Here", Metalworking Production, Vol. 122, Number 10, October, 1978, pp. 60-61, 65.

Describes some current considerations in loose abrasive and blast deburring.

A3. McDonald, James, "Blow Your Machining Problems Away", Machine and Tool Blue Book, October, 1978, pp. 117-121.

Miniature abrasive jets deburr miniature screw machine parts.

1979

A4. McDonald, James, "Debugging Deburring with Abrasive Jet Machining", Manufacturing Engineering, July, 1979, p. 55.

Presents a basic list of applications of microblasting.

A5. McDonald, James, "When Ordinary Methods Can't Cut It - Try AJM", Cutting Tool Engineering, March/April, 1979, pp. 8-11.

Provides basic process description of miniature abrasive jet deburring.

A6. Whinney, Cecilia D., "Blasting Processes Involved in Deburring", SME paper MR79-332, 1979.

ABRASIVE FLOW

1978

B1. Reynolds, T. A., "Deburring - 3. Using Abrasive Flow", Production Engineer (London), Vol. 57, n.6, June, 1978, pp. 35-38.

General discussion of abrasive flow deburring.

B2. Stackhouse, John, "AFM is More Than Deburring", Modern Machine Shop, December, 1978, pp. 115-119.

General article on the uses of abrasive flow machining.

LOOSE ABRASIVE PROCESSES

1978

D1. *Podesta, D., "Effects of the Parameters of Abrasive Grains on Metal Removal Rates in Loose Abrasive Systems", Finishing Industry, Vol. 2, n.2, February, 1978, pp. 21-24, 29.

Presents research results on effect of particle size, material and other parameters on stock removal.

BARREL TUMBLING

1971

D2. "Freon Deflashing for Cost Savings", Plastics and Rubber Weekly, No. 402, October 29, 1971, p. 15.

1977

D3. "Barrel Type Unit for Cleaning and Polishing of Components", Maschinenmarkt, Vol. 83, Number 7, 1977, p. 107 (in German).

D4. Catier, E., "Abrasives for Grinding, Descaling, Scurfing, Polishing, and Burnishing", Traitements de Surface, Vol. 13, No. 157, 1977, pp. 5, 7-9, 11, 13-19, 21-22 (in French).

D5. Yashcheritsyn, P. I., A. N. Martynov and V. M. Romanov, "Special Features of Centrifugal Method of Treating Flat Surfaces with a Free Abrasive", Mashinostroenie, Number 1, 1977, pp. 167-170 (in Russian).

1978

D6. "1978 State of the Industry Report", Precision Metal, November, 1978, Volume 36, No. 11, p. 21-40.

This survey of the poured metal industry indicates that the average number of vibratory or barrel tumbling machines is 2.1 per plant. Three mechanical trimming presses and 2.1 hydraulic presses are also average per plant in this industry.

D7. Burkart, W. and O. Schmid, "New Developments in Barrel Finishing of Metal Parts", Metalloberflache (Munchen), Vol. 32, No. 11, 1978, pp. 519-520 (in German).

D8. *Gillespie, LaRoux K., "Barrel Tumbling: Is It Still Economical?", Machine and Tool Blue Book, September, 1978, pp. 126-135.

Presents method for making an economic analysis of barrel tumbling. Article describes advantages of barrels and presents comparisons to vibratory capabilities.

D9. Poll, Gerard H., Jr., "Shake and Roll", Products Finishing, September, 1978, pp. 44-52.

Presents an interview with the president of one of the country's largest mass finishing job shops.

1979

D10. "Cuts Cost in Making Metal Parts", Product Engineering, January, 1979, pp. 41-44.

Article details the energy consumed in manufacturing two parts from bar or forging versus powdered metal. Deburring energy requirements are shown.

CENTRIFUGAL BARREL TUMBLING

1957

D11. Black, T. W., "Fundamentals of Barrel Finishing, Part 2: How to Get Started", Tool Engineer, May, 1957, Vol. 38, pp. 113-120.

Presents a basic introduction to establishing a barrel finishing operation.

1979

D12. "Manufacturing Update", Manufacturing Engineering, July, 1979, p. 17.

Centrifugal barrel tumbling radiuses ceramic capacitors. Radii are controlled to $\pm$ 0.001 inch.

D13. Davies, Rodney Chapman, "Orbital Finishing of Miniature Parts", SME Paper MR79-504, 1979.

Presents a number of examples of the use of centrifugal barrel finishing.

MAGNETIC LOOSE ABRASIVE

1968

D14. Babichev, A. P. and V. A. Morozov, "The Magnetic-Vibration Method of Processing Machine Components", Prcizvodstvenno-tekhnicheskii Byulleten, No. 3, 1968 (in Russian).

D15- *Morozov, V. A., "Magnetic-Vibration Processing of Machine Components," Russian Engineering Journal, Volume 50, number 3, 1970, pp. 55-59.

Excellent treatment of the variables influencing metal removal in magnetic-vibratory finishing.

1976

D16. Bazarnov, Yu A. and I. Yu Sakulevich, "Equipment for Magnetic-Abrasive Polishing", Magnitno-Abrazivn Polirovanie Detalei (magnetic-abrasive polishing of components), Minsk, 1976, pp. 95-99 (reference R. Z. M. 1977, 1B685) (in Russian).

D17. Makarevich, S. S., F. Yu Sakulevich and L. M. Kozhuro, "Analysis of the Trajectory of a Machined Component Surface in Bulk Magnetic-Abrasive Polishing", Magnitno-Abrazivn Polirovanie Detalei, Minsk, 1976, pp. 86-91 (in Russian).

D18. Nalivka, G. D., N. S. Khomich and L. M. Kozhuro, "Magnetic-Abrasive Machining", Magnitno-Abraziun Polirovanie Detalei, Minsk, 1976, pp. 107-109 (in Russian).

D19. Sakulevich, F. Yu and L. M. Krevchen Ko, "Effect of Magnetic-Abrasive Polishing on Surface Quality in Polishing Surfaces of Ferro-Magnetic and Dia-Magnetic Materials", Magnitno-Abrazivn Polirovanie Detalei, Minsk, 1976, pp. 67-73 (in Russian).

1978

D20. Dehoff, A., R. Goerke, R. Krull, W. Mattke, and E. H. Muller, "Magnetic Abrasive Precision Deburring", Fertigungstech Betr., Vol. 28, number 1, January, 1978, pp. 16-18 (in German).

D21. Shushkevich, V. A., et. al., "Investigation of Bulk Magnetic-Abrasive Polishing", Russian Engineering Journal, Vol. 58, No. 4, 1978, pp. 50-51.

VIBRATORY FINISHING

1966

D22. Kartyshev, B. N., "Vibratory Polishing - Drum Mounted on Inflated Rubber Shock Absorbers", Machines & Tooling, No. 7, 1966.

1968

D23. Kartyshev, B. N. and A. E. Rodichenko, "Vibratory Polishing Drum With Overrunning Mechanism", Machines & Tooling, No. 7, 1968.

1969

D24. *Izotov, E. N., "Design of Vibratory Abrasive-Polishing Equipment", Russian Engineering Journal, 1969, number 8, pp. 57-59.

Presents design information describing the usable limits of machine motion in vibratory deburring.

D25. *Kartyshev, B. N., et. al., "How Disposition of Components Can Affect Vibratory-Treatment Characteristics", Russian Engineering Journal, 1969, number 3, pp. 59-62.

This study explored the effect that fixtured workpiece angle to abrasive movement has on metal removal and residual stresses.

1976

D26. Belykh, N. D., "Finish Vibratory Machining of Components in Organic Media", Sistemry Avtomat. Upr. Metallorezh Stankami i Tekhnol Protsessami, Rostov-on-Don, 1976, pp. 58-63.

Walnut shells and fruit stones combined with steel balls provide good finish.

1977

D27. "A Dozen Ways to Cut Cost of Vibratory Finishing", Products Finishing, Vol. 42, number 2, 1977, pp. 82-84.

Basic discussions of current uses of vibratory finishing.

D28. "Editor's Notes", Automatic Machining, May, 1977, pp. 32-38.

Article contains some brief comments about TEM and vibratory deburring.

1978

D29. "Combination Vibratory-Rotary Action Speeds Deburring Process", Tooling & Production, September, 1978, p. 421.

The addition of centrifugal action to vibratory motion is used to increase finishing times by a factor of 30.

D30. "Continuous-Feed Vibrator Cuts P/M Finishing Costs", Precision Metal, July, 1978, p. 36.

Continuous feed vibratory machines reduce costs from $672 per day to $232 a day. The cost differential is due primarily to the change from batch loading to continuous feeding.

D31. "15 Years of Vibratory Deburring at Hughes", Manufacturing Engineering, November, 1978, pp. 69-70.

In 20 years one plant reduced deburring workloads from a high of 150 people to 8. Most of this reduction was due to the addition of vibratory finishing machines which deburred parts 1 inch and larger. Many parts had tolerances of only 0.001 inch.

D32. Evans, Richard, and Steve Barto, Tooling & Production, November, 1978, pp. 102-103.

Vibratory deburring increase production output by a factor of up to 8:1 over hand deburring.

D33. Hignett, Bernard, "Mass Finishing", Metal Finishing, July, 1978, pp. 17-21.

Presents a general summary of the mass finishing processes.

D34. Miller, Paul C., "Press Time Notes", Tooling and Production, December, 1978, p. 4.

Presents some machine design aspects of vibratory deburring equipment.

1979

D35. "Delicate Deburring from Texas", Tooling & Production, February, 1979, p. 183.

Describes operation of Boulton's "Solar" orbital agitator finishing machine.

D36. "Laboratory Optimizes Finishing Operations", Tooling and Production, January, 1979, pp. 76-77.

Basic description of mass finishing.

D37. "Systematic Deburring", Tooling & Production, February, 1979, p. 71.

Describes an automated deburring vibratory line at Texas Instruments.

D38. Kittredge, John B., "Calculate the Number of Parts that can be Processed in a Vibratory Finishing Machine", Industrial Finishing, August, 1979, p. 31.

Presents a basic and useful guide to selecting the number of parts which should be put in vibratory equipment.

D39. Sofronas, A., and S. Taraman, "Model Development and Optimization of Vibratory Finishing Process", Int. Journal of Production Research, Vol. 17, No. 1, 1979, pp. 23-31.

This article presents a statistical approach to evaluating performance of vibratory finishing processes. While the paper basically describes the statistics used, data is presented of use to manufacturers.

D40. Stauffer, Robert N. "What You Should Know About Vibratory Finishing", Manufacturing Engineering, July, 1979, pp. 48-54.

This article presents a rather complete overview of equipment designs available in vibratory deburring machines.

SANDING

1973

E1. Pesce, Lou, "Deburring - Various Methods", Electronic Packaging and Production, December, 1973, p. 74.

This article briefly highlights the deburring processes used in printed circuit board production.

1979

E2. "Teamwork Develops Breakthrough in Manufacturing Technology", Boeing Vertol Company News, Philadelphia, 1979.

3M Scotchbrite finishing machine deburrs clad soft aluminum aircraft components.

E3. Carlson, G. A., Jr., "Advances in Abrasive Finishing", Manufacturing Engineering, February, 1979, pp. 59-62.

Describes some of the recent approaches for brush and flap wheel deburring and finishing.

MECHANIZED OR TOOLED MECHANICAL METHODS

1974

F1. Harper, J. D., and L. Clarke, "User Finish Requirements - The Foundryman's Point of View", Proceedings Fettling and Cleaning of Castings Conference, Session 1, BCIRA, Alvechurch, England, September 24-26, 1974.

1977

F2. "Machine Assisted Finishing of Steel Castings - Metal Removal", Steel Founders' Society of America Report No. 77-176, June, 1977.

F3. Frazier, R., "Latest Mechanical Finishing Methods for Die Cast Parts," Transactions 9th SDCE International Die Casting Congress, June, 1977, paper G-T77-021.

F4. Levin, Louis and Samuel, Practical Benchwork for Horologists, Louis Levin and Son, Inc., Culver City, California, 1977.

This book on watch fabrication and repair contains several examples of techniques used to deburr watch parts.

F5. Kalafat, E., and C. H. Wong, "Initial Survey of Robot Application to Fettling of Castings", Report published by University of Birmingham, Graduate School of Machine Tool Technology, January, 1977.

F6. Weichbrodt, Bjorn, "Some Special Applications for ASEA Robots - Deburring of Metal Parts in Production", SME paper MS77-736, 1977.

Describes the needs inherent in a robot in order to perform deburring.

1978

F7. "Ballizing Breakthrough: Better Holes, Blistering Rates, Bargain Costs", Machine and Tool Blue Book, September, 1978, pp. 110-115.

Two deburring uses of ballizing are described.

F8. "Production Tips: Fast Deflashing", Production, September, 1978, p. 87.

A special design yet simple machine shears die casting flash from carbureator holes.

F9. Beckman, Lennart, "Deburring with an Industrial Robot", Proceedings International Symposium on Industrial Robots, May, 1978, Stuttgart, Germany.

Industrial robot holds motorized tools in its "hand" and deburrs intersecting holes. Payoff for one of these robots was 1.4 years on a shift basis. Robot has positioning capabilities of ± 0.2 mm (± 0.008).

F10. Derganov, B. S., V. I. Ustyantsev, P. M. Gavrilin, E. M. Kricheuski, and V. I. Kononova, "Removal of Internal Burrs from Arc-Welded Tubes", Stal., number 2, February, 1978, p. 162 (in Russian).

Rolling cutters remove burrs. Burrs left by process were less than 0.2 mm high.

F11. Hageluken, H. P. and W. Drake, "Economic Deburring with Fully Automatic Honing Equipment", M.A.V., Vol. 1, 1978, pp. 16-20.

F12. Onokhin, R. D., "Efficiency of Internal Deburring of Pipes of Long Length", Tsvet. Met., number 8, August, 1978, pp. 84-87 (in Russian).

F13. *Munson, George E., "Foundries, Robots and Productivity," Proceedings International Symposium on Industrial Robots, May, 1978, Stuttgart, Germany.

Unimate robot removes casting gates via flame cutting. Repeatability was better than 1.5 mm (0.060 inch) from gate to gate. The limitations and capabilities of the robot are discussed.

F14. *Rooks, B. W., "The Fettling of Castings - A Job for Industrial Robots", Proceedings International Symposium on Industrial Robots, May, 1978, Stuttgart, Germany.

Presents an analysis of the use of robots for removing flash, gates, and runners from cast parts. Labor costs for such activities manually represent 15-20 percent of the total labor cost of producing castings.

F15. Tanner, William R. (ed.), Industrial Robots, Vol. II, SME, 1978.

Contains some applications for robots in deburring.

HAND DEBURRING

1955

G1. *Schlesinger, Klaus L., "Gadgets: Deburring Die", Tool Engineer, Vol. 34, August, 1955, p. 77.

Slotted eyebolt was difficult to deburr. Standard button thread die slots were smaller than slot causing die to hang up in slots. The problem was solved by pouring Kirksite in slots leaving a hole large enough to fit O.D. of bolt thread.

1978

G2. Gillespie, LaRoux K., "Hand Deburring: A Plague or the Most Economical Way?" Machine and Tool Blue Book, November, 1978, pp. 102-113.

Describes some of the considerations some companies must make if hand deburring costs are to remain low.

G3. *Gillespie, LaRoux K., Hand Deburring Guide, Bendix Kansas City Division Report BDX-613-2089R, September, 1978.

This 103 page guide describes one company's burr related standards, inspection practices, research on hand deburring, in-house hand deburring practices and the 16 categories of hand deburring tools.

1979

G4. Gillespie, LaRoux K. and J. C. Bolinger, "Training for the Deburring of Precision Miniature Parts", SME paper MRR79-501, 1979.

This paper describes a training program developed to provide individuals capable of deburring very small precision parts in a job-shop environment.

BRUSHING AND BUFFING

1979

H1. "Steering Shafts Broached, Deburred at High Speed", Machine and Tool Blue Book, April, 1979, p. 145.

Machine automatically broaches and deburrs steering column shafts.

H2. Gillespie, LaRoux K., "Give Your Deburring Problems the Brush Off", Machine and Tool Blue Book, April, 1979, pp. 107-117.

Describes the 10 factors affecting brush aggressiveness as well as non-traditional brushing materials. Economics of several brushing situations are presented.

THERMAL ENERGY METHOD

1975

J1. "TEM, Thermisches Entgraten von Metallen und Kunststoffen: Werbeprospekt", Stuttgart: Bosch-Industrieaus-rustungen, 1975 (in German).

1976

J2. Hallman W., "Studie Zur Einfuhrung der Thermischen Entgrat-Methode im IZ Automobilbau", Hohenstein-Ernstthal, IFA-Ingenieurbetrieb, 1976 (in German).

1977

J3. Tungler, M., Einige Aspekte beim Chemisch-thermischen Entgraten am Beispiel des Zinkdruckgusses, Diplomarbeit, TH Karl-Marx-Stadt, 1977 (in German).

1978

J4. "Thermal Deburring on Hot Streak", Manufacturing Engineering, December, 1978, pp. 36-37.

This interview with the president of Surftran reveals that 250 thermal energy method machines are now in plants around the world. Current emphasis is on building complete finishing system. Eventually 10 job shop facilities having TEM will be available in the U.S.

J5. *Hallmann, W., "Thermal Deburring: An Effective Process", Fertigungstech Betr, Vol. 28, number 1, January, 1978, pp. 12-14 (in German).

J6. Rakowski, Leo "Productivity Improvement Corner: Borrowed Machine Cuts Lock Deburring Costs by 70 Percent", Machine and Tool Blue Book, October, 1978, pp. 135-136.

Thermal deburring unit proves effective on deflashing of automobile lock cylinders. The borrowed unit saved 70 percent of the deflashing costs.

J7. *Leisner, Ernst "Deburring - 1. The Thermal Energy Method", Production Engineer (London) Vol. 57, N6., June, 1978, pp. 19-22.

Describes use and capabilities of thermal energy deburring method.

J8. *Tungler, M., and H. Wicht "Chemical and Technical Relationships in the Thermal Deburring of Metal Components", Fertigungstech Betr, Vol. 28, number 1, January, 1978, pp. 8-11 (in German).

Describes thermal deburring process.

1979

J9. "Thermal Energy Method Cuts Deburring Costs over 60%", Cutting Tool Engineering, January/February, 1979, pp. 18, 20.

Results of ARO Corporation's four year experience with the thermal energy method of deburring. Thirty percent of this company's parts can be deburred by this process.

J10. Jameson, E. C., Thermal Machining Processes, SME, 1979.

This book covers thermal deburring and a variety of thermal machining processes.

PLASMA DEBURRING

1977

K1. "Automatic Burr Trimming by Arc-Discharge Method", Japan Ind. Technol. Bull., Vol. 5, number 8, Nov., 1977, p. 2.

Arc discharge removes burrs.

CHEMICAL DEBURRING

1977

M1. "Finishing Aluminum and Mild Steel Pressed Products", Sheet Metal Industry, Vol. 54, number 12, Dec., 1977, pp. 1213, 1217.

Describes chemical deburring of low carbon steel.

1979

M2. *Dargis, Ray, "Chemical Deburring and Finishing of Small Parts", Handbook used in 1979 SME deburring session.

Describes the basic advantages of chemical deburring.

CHEMICAL CENTRIFUGAL BARREL FINISHING

1978

P1. Dargis, Raymond G., "Buffered Chemical Accelerated Mechanical Deburring", SME Paper MR78-640, 1978.

Describes the application and advantage of chemically accelerated centrifugal barrel finishing.

1979

P2. Hignett, J. Bernard and E. Barry McGrath, "Chemically Accelerated Centrifugal Barrel Deburring and Finishing", SME Paper MR78-965, 1978; similar in Industrial Finishing, March, 1979, pp. 40-43.

Describes the advantages and uses of centrifugal barrel finishing with chemical additives.

ELECTROCHEMICAL DEBURRING

1972

Q1. *Egorov, A. M. and A. S. Titov, "Electrochemical Machining for Rounding-off Complex-Shaped Workpieces", Russian Engineering Journal, Vol. 52, number 8, 1972, pp. 44-46.

Describes the observations made in electrochemical deburring fir tree slots on turbine blades.

Q2. Pavlova, G. L., and Yu K. Kobov, "Electrochemical Deburring", Machines and Tooling, Volume 43, number 7, 1972, p. 62.

Basic discussion of deburring connecting rods and gear teeth.

Q3. Schafer, F., "Elektrochemisches Badentgraten" Metalloberflache, Vol. 28, No. 3, 1974, pp. 84-87 (in German).

1975

Q4. Atkey, Martin, "Deburr Slots Into Quality Production", Metalworking Production, February, 1975, p. 85.

Electrochemical slotting machine eliminates the need to deburr slots on transmission parts.

1978

Q5. Graham, D., "Deburring - 2. Electrochemical Machining", Production Engineer (London) Vol. 57, n6, June, 1978, pp. 27-30.

Presents a general discussion on electrochemical deburring and shows several examples of use.

Q6. Kellock, Brian, "When Many Hands Do Not Work (Automatic Deburring)," Machinery and Production Engineering, June 7, 1978, Vol. 132, number 3414, pp. 26-27.

Describes an electrochemical deburring operation.

Q7. Raohev, R., T. Nikov, and E. Devedzhiisha, "Electrochemical Polishing and Deburring of Gears", Mashinostroene (Sofia), Vol. 27, No. 1, 1978, pp. 24-27 (in Russian).

1979

Q8. *Gillespie, LaRoux K., "Deburring in Hard-To-Reach Areas a Headache? Try ECD", Machine and Tool Blue Book, January, 1979, pp. 90-103.

Presents a general overview of ECD plus photos of actual edge conditions. Economics, considerations in equipment purchase and effects of burr size are discussed.

ELECTROPOLISH DEBURRING

1968

R1. Siegel, B., "Oberflachenbehozndlung Jon Schuttfahigen Massenteilen durch elektrolytisches Polieren und Entgraten," Industrie-Anzeiger, Vol. 90, n33, 1968, pp. 670-672 (in German).

1972

R2. Siegel, B., "Elektropolieren und Elektrochemisches Entgraten im Maschinenbau, Chemieanlagenbau und inder Elektrotechnik" VDI-Berichte, number 183, 1972, pp. 13-20 (in German).

1974

R3. Schafer, F., "Elektrochemisches Entgraten in Badanlagen," VDI-Bildungswerk, BW2632, VDI-Verlag Dusseldorf, 1974 (in German).

1976

R4. Zerweck, K., "Entgraten durch elektrochemisches Ober flachen abtragen" HGF-Bericht 76/92, 1976 (in German).

1978

R5. Siegel, Bruno, "Applications for Electrochemical Polishing and Deburring", Werkstattstechnik, October, 1978, number 10, pp. 637-640 (in German).

Describes some of the surface effects or benefits of electropolishing.

R6. Siegel, Bruno, "Effect of Electrochemical Deburring", Galvanotechnik, Vol. 69, number 9, September, 1978, p. 803-807 (in German).

Electropolishing increases brightness, adhesion and wear of electroplated deposits.

R7. *Zerweck, Klaus, Untersuchungen Zum Polieren und Entgraten durch elektrochemisches Oberflachenabtragen, Krausskopf-Verlag Gmbh, Mawz, West Germany, 1978 (in German).

This major study on electropolishing and electropolish deburring illustrates the variation burr size and edge angle have on the final burr-free part. In addition the effect of a part's location relative to the cathode is studied as are several electrolyte variations. Surface finish and stock loss are measured and described in detail in this 103 page report. Over 120 references are cited.

MULTIPLE PROCESSES

1978

U1. *"Data Sheets on Deburring Details Used in Japanese Industry", compiled by Society of Cutting Fluid and Cutting Technology, Japan, circa 1978, No. 8 (in Japanese).

This document lists several case histories of deburring. Initial burr size is typically given as is final edge break.

U2. *"How to Eliminate Burrs and Edge Defects", preprint of 40th General Assembly of The Society of Cutting Fluids and Cutting Technology, December 5, 1978 (in Japanese).

This 184 page report summarizes the deburring techniques reported by 86 major companies in Japan. The largest of the five sections present tabled case histories defining feeds, speeds, material, location of burr, shape of part, deburring tools, etc. This is one of the finest yet simplest approaches yet used to document industrial usage.

U3. 1979 Finishing Industry Yellow Pages, Spectech Publications Inc., Oxnard, California, 1978.

This directory of manufacturers and service organizations is one of the most complete of its kind (228 pages).

U4. *Gillespie, LaRoux K., (ed.), Advances in Deburring, SME, 1978.

This 513 page book presents 20 chapters of detailed and general information on product design, burr formation and removal, specific deburring processes, and trends in deburring.

U5. *Gillespie, LaRoux K., "Deburring: An Annotated Bibliography, Vol. V", SME Paper MRR78-10, 1978.

This annotated bibliography lists 204 articles and reports on burrs, burr prevention and deburring. Entries are indexed by type of process and 14 other categories. Publication language and author indexes are also included.

U6. Goldstein, Raymond, Needed Research and Development on Burrs and Deburring for Improved Fuze Production, U.S. Army Armament Research and Development Command, Report TFFB IR 101, March, 1978.

Describes basic deburring process capabilities and defines research program needs for reducing weapon deburring costs.

BURR FORMATION AND PROPERTIES

1962

V1. Pastuhov, I. M., "Measurement of Small Radii of Curvature", Measurement Techniques, 1962, pp. 652-653.

Describes convenient method for measuring radii of very small arcs. This method has been used to report edge breaks from deburring.

1976

V2. Krumrei, Erich W., "Machining Applications and Performance of Compax Blank Tools and BZN Compact Tools", General Electric Co. brochure SMD 76-254, 1976.

Compacted diamond tools eliminate the welding of aluminum to carbide inserts. In turn this prevents visibly unallowable burrs from forming on one aluminum part.

1978

V3. Reed, Walter J., "Manufacturing Scouting Report", Machine and Tool Blue Book, October, 1978, p. 131.

Machining aluminum at 6000 sfpm results in reduction of burr size.

V4. *Schafer, Friedrich, "Burr Formation and Deburring During Contour Milling", VDI Z Vol. 120 n1-2, January, 1978, pp. 47-55 (in German).

This article describes the wide variety in burr sizes and shapes one can obtain in contour milling.

1979

V5. Lambert, Brian, "Prediction of Thrust Force, Torque and Burr Height in Drilling Titanium", SME paper MR79-363, 1979.

BURR PREVENTION AND MINIMIZATION

1976

W1. Harris, William T., Chemical Milling, Clarendon Press; Oxford, London, 1976, p. 6.

Author indicates that in printing, the advantage of a chemical etched line over an engraved one is that the ink-retaining groove is produced without an upstanding groove which would wear out and eventually result in a faint print.

W2. "NSMPA's 17th ...", Automatic Machining, June, 1978, pp. 28-38.

Editor indicates that when polygon shapes are produced on the screw machine few if any burrs are left on the O.D., if a job is properly setup. Users of eight spindle automatics seem more concerned than users of other machines about avoiding creation of burrs. Reaming holes on an automatic after cross drilling is cheaper than trying to get rid of an internal burr later.

1979

W3. "Faster Drilling With the Bickford Point" Manufacturing Engineer, January, 1979, p. 66.

Article indicates that new drill point by Gidding St. Lewis-Bickford Machine Co. produces burr free break through.

W4. "Piggy-Back Tool Eliminates Burrs", Production, July, 1979, p. 103.

Chamfer tool piggy-backed on cutoff tool removes cutoff burrs operation.

DESIGNING FOR MINIMIZING BURR PROBLEMS

1960

X1. Burghardt, Henry D., Aaron Axelrod, and James Anderson, Machine Tool Operation, Part II, McGraw Hill Book Company, New York, 1960, pp. 50, 51, 234, 235, 444.

This textbook for training machinists describes the problems burrs will cause in part accuracy.

1973

X2. Mayer, J. E., Jr. and D. J. Stauffer "Effects of Tool Edge Hone and Chamfer on Wear Life", SME paper MR73-907, 1973.

At high speeds tool life decreases as the amount of tool chamfer increases.

1977

X3. Huber, Robert F., "We've Jumped Productivity Overall by 45%." Production, November, 1977, pp.

Univel methods engineering approach helps reduce sampling for burrs from every 15th part to every 50th. The computer automatically generated the new time standard.

1978

X4. "News Briefs: Special Plate Fabricating", Tooling and Production, September, 1978, p. 124.

Special design punches are used to provide 1/16 inch high burrs on ship decks. These burrs are used to improve traction.

X5. Barash, M., "Movable Insert Aids Flashless Forging Die", Manufacturing Engineering, December, 1978, p. 39.

Die design concept which allows flashless forgings is shown.

X6. Hignett, J. B., "Practical Development of Deburring in General Manufacturing", Proceedings AES Second Decorative Plating Symposium, 1978, pp. 42-59.

Provides a broad treatment of economics, capital equipment, value engineering and related aspects of deburring.

1979

X7. "A Guidebook for Designing Piece Parts", brochure by Dayton Rogers Mfg. Co., Minneapolis, Minnesota, number F169, circa 1979.

Presents a number of useful design considerations about edge quality and burrs on sheet metal parts.

X8. "Capital Spending: Up Again in 1979", Production, January, 1979, pp. 63-65.

Annual survey indicates manufacturing companies will spend 6.2 percent of their capital investment dollars for finishing equipment.

X9. "Sharp Corners ... No Burrs", Automatic Machining, June, 1979, pp. 22-23.

Describes some of the problems lack of burr notes generate.

X10. "Unique Tooling Solves Multiple-Hole, Dual-Type Punchy Puzzle", Machine and Tool Blue Book, April, 1979, p. 151-152.

Ship deck utilizes burrs to provide safe traction.

X11. Whaley, Robert, "Burrs by Appointment", Tooling and Production, January, 1979, p. 95.

Presents suggested allowable burr size on stamped parts.

1956

Y1. "Bursten von Zahnradern in einer Entgratmaschine", Werkstattstechnik und Maschinenbau, 1956, No. 3, p. 140 (in German).

1966

Y2. Vurbshtein, I. E., Mechanization of the Deburring Process, MDNTP, im. Dzerzhinskogo, M., 1966, pp. 7-33 (in Russian).

Y3. Holtz, J., "Erfassung und Klassifizierung von Graten in der Fertigung", Studienarbeit am Institut fur Ind. Fertig und Fabrikbetrieb der Universitat Stuttgart, 1973 (unveroffentlicht) (in German).

1975

Y4. Grot, H. E., "Maschinelles Entgraten von Metallen, Ruckblick und Zukunfts-aussichten", Zeitschrift fur Wirtschaft-liche Fertigung, Vol. 70, number 6, 1975, pp. 320-326 (in German).

Y5. Fink, P., "Fachtagung Entgraten", TZ f. Prakt. Metallbearbeitung, Vol. 70, No. 6, 1976, pp. 186-189 (in German).

Y6. Schafer, F., Untersuchungen zur Gratbildung und Zum Entgraten insbesondere beim Umfangsstirnfrasen, University of Stuttgart Dissentation, 1976.

1977

Y7. Grindrod, S. H., "Deburring: A Review of Methods and Equipment", Production Engineer, January/February, 1977.

1978

Y8. Lyashchenko, A. M., V. I. Kibko, and A. A. Shatova, in "Cleaning and Deburring of Iron-Nickel Strip", Elektrofiz i elektrokhim metody obrab ot materialov, Moscow, 1978, pp. 69-72 (reference R.Z.M. 1978, 7B192) (in Russian).

Y9. Zachau, H., "Deburring: A Critical Item in Increasing Productivity in the Metalworking Industry", Fertigungstech. Betr. Vol. 28, number 1, January, 1978, p. 7 (in German).

Y10. Pooler, Noel, "Deburring to Improve Function in the Automotive Industry", SME Paper MR79-329.

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A1, 2, 4; D1, 6, 13, 16, 20, 24, 29, 32, 34-37, 40; E2, 3; F2, 6-11, 13-15; G1-3; H1; P1; Q6, 8; U1, 3-5

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4. Aluminum
   D31, 32, 39; E2; J5, 9; M1; Q8; V2, 3; X11

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