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AN ANNOTATED READING LIST FOR
CONCURRENT ENGINEERING

James P. Pennell
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July 1989

Prepared for
Office of the Assistant Secretary of Defense for
Production and Logistics (OASD(P&L))

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13. ABSTRACT (Maximum 200 words) The purpose of IDA Document D-571 is to provide an annotated bibliography on concurrent engineering. This document is intended to help the reader who is unfamiliar with concurrent engineering understand the several fields of study involved and also to allow those who are experts in some narrower subject gain an appreciation for work in related topics.					
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An Annotated Reading List for Concurrent Engineering

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1. Background

This document is provided in response to a request by the sponsor for information to supplement IDA Report R-338, *The Role of Concurrent Engineering in Weapons System Acquisition*. That report describes the findings of Phase I of a joint IDA, DOD, industry, and academia investigation of concurrent engineering.

2. Objective

This annotated bibliography is intended both to help the reader who is unfamiliar with concurrent engineering understand the several fields of study involved and also to allow those who are experts in some narrower subject gain an appreciation for work in related topics. It cites a variety of sources and gives a short note about each.

3. Using the List

The authors have attempted to avoid editorial judgements in the bibliography. The reader should be aware that individual works are sometimes in conflict and that inclusion of a particular piece in this list does not constitute an endorsement by the authors.

3.1. Getting Started

The following works are recommended for the reader interested in getting an overview of the problems facing U.S. companies and some of the most promising solutions:

- Ackerman *et al.* (1987) provide an excellent guide to understanding and managing "the process."
- Deming (1986) gives an excellent exposition of need to understand variability and his famous 14 point management philosophy.
- Garvin (1987) defines eight dimensions of quality.
- Hayes (1988) offers a manager's perspective of the problem and some solutions.
- Ishikawa (1982) presents a practical guide (with easy to use tools) for implementing quality control at the working level.
- Schonberger (1987) describes Japanese and American modern manufacturing techniques.

3.2. Statistical Process Control

Readers who are interested in statistical process control can consult the 1985 ANSI Standard or Wheeler (1986) for a description of the basics of control charts. More advanced tools are described in Page (1954), Hunter (1986), and Woodward (1964).

3.3. Design of Experiments

Design of experiments is described by Box *et al.* (1978) Copp (1984), Kackar (1985), Schmidt (1988), Shoemaker (1988), Snee (1979), and Taguchi (1988). The reader will quickly become aware of a controversy concerning tactics of experimental design among those who follow the recommendations of Taguchi and those who prefer other approaches. If the reader wishes to pursue this subject, then Kackar's 1986 article and Schmidt's text are good starting points. Other commentaries such as Box (1988), Leon *et al.* (1987), Kusaba (1988), and Winner (1988) can be found in the bibliography.

3.4. Design for Assembly

Design for assembly is described by Boothroyd and Dewhurst, Gager (1986), and Schreiber (1985).

3.5. Productivity and Quality

Readers seeking information about problems with productivity and quality from the government's view can consult two blue-ribbon reports Costello (1988) and Packard (1986). They can also find recommended approaches for acquisition programs in Willoughby (1986), the Air Force's R&M 2000, and DoD 4245.7. Government programs to motivate and reward improvements in productivity among federal employees are described by Feher *et al.* (1985) and Riedel *et al.* (1987).

3.6. Manufacturing

Black (1988), Freeman (1985), Gansler (1988), Haas (1987), Hayes (1988), Jorgen (1986), Knight (1989), Monden (1983), Schonberger (1987), and Seifert (1988) discuss various aspects of manufacturing. Jorgen's collection of essays is a good starting point for the reader who is interested in becoming familiar with the role of computers in improving manufacturing.

3.7. Education and Training

The role and importance of education are discussed in several papers. Easton, Roberts, and Tiao (1988) discuss the need for improvements in the business schools, Gomory and Shapiro (1988) have a dialogue on the relationship between the university and industry, and Hutchinson and Muller (1988) critique a proposal for revising the engineering curriculum. Landwehr and Watkins (1987) provide a text that can supplement education in the primary and secondary schools, and both Marquardt (1984) and Tribus (1988) address the educational needs of senior management. Rohlen (1987) shows why the Japanese educational system works.

3.8. Research Directions

Research directions and reports of current research can be found in NCMS (1988), DARPA (1987), Dornfield (1989), and Fox (1989).

4. Caution

The attached bibliography is not exhaustive, it represents principal works that the authors' found useful during the first phase of investigating concurrent engineering. Readers can develop their own reading list after consulting the works cited here or they may choose to contact any of the professional societies that have continuing activities in a particular subject area such as the Institute of Electrical and Electronic Engineers, the Institute of Industrial Engineers, the American Society for Quality Control, the American Statistical Association, the American Society of Mechanical Engineers, the American Chemical Society, American Production and Inventory Control Society, and the Japanese Union of Scientists and Engineers.

BIBLIOGRAPHY

Ackerman, Roger B. and et al., *Process Quality, Management & Improvement Guidelines*, AT&T Bell Laboratories, 1987.

This book gives rules for process management and improvement. An appendix provides rule-of-thumb for techniques to apply at each step of seven-step procedure. Describes several software tools.

American Supplier Institute, *Third Supplier Symposium on Taguchi Methods*, American supplier Institute, Detroit, MI, October 8-9, 1985.

This document provides the proceedings of the third symposium on Taguchi Methods. Sponsorship changed from Ford Motor Company to American Supplier Institute.

American Supplier Institute, *Fourth Symposium on Taguchi Methods*, American Supplier Institute, Detroit, MI, October 1986.

This symposium is a continuation of the effort begun by Ford Motor Company in 1984.

American Supplier Institute, *Fifth Symposium on Taguchi Methods*, American Supplier Institute, Detroit, MI, October 1987.

This symposium is a continuation of the effort begun by Ford Motor Company in 1984.

ANSI, and ASQC, *American National Standard: Guide for Quality Control Charts, Control Chart Method of Analyzing Data, Control Chart Method of Controlling Quality During Production: ASQC Standard B1-1985, B2-1985 & B3-1985 ANSI Z1-1985, Z1.2-1985 & Z1.3-1985*, American Society for Quality Control, Milwaukee, WI, 1985.

These standards evolved from the original work of Dodge, Ashcroft, Deming, Simon, Wareham, and Gaillard for the War Department in 1940. They are contained in a single document. The document shows the user how to use statistical process control.

ASD(A&L), *Transition from Development to Production DoD 4245.7-M*, Department of Defense, Washington, DC, September 1985.

This manual contains "The Templates." They provide an example of how one goes about ensuring that the transition from development to production is as smooth as possible by providing the discipline to help users make wiser decisions. A "Template" describes specific areas of risk and outlines steps for reducing risk. There are separate templates for over 40 tasks.

Bisgaard, Søren, *A Practical Aid for Experimenters*, University of Wisconsin-Madison, Madison, WI, 1988.

The author provides a workbook of experimental design worksheets. The worksheets provide experimental layouts for eight and sixteen run experiments, with Yates algorithm for each, plots for square, cube, and double-cube, and normal probability paper for eight and sixteen run experiments.

Black, J. T., "The Design of Manufacturing Cells (Step One to Integrated Manufacturing Systems)," *Proceedings of Manufacturing International '88*, vol. III, p. 143, April 19, 1988.

The author discusses the five basic kinds of manufacturing systems, including the newest-cellular manufacturing systems (CMS).

Black, J. T. and B. J. Schroer, "Decouplers in Integrated Cellular Manufacturing Systems," *Journal of Engineering for Industry*, vol. 110, pp. 77-85, ASME, February 1988.

The authors describe a new element, a decoupler, that must be added to the cellular manufacturing system to allow it to satisfy the primary functional requirement of flexibility.

Boothroyd, G. and P. Dewhurst, *Early Cost Estimating in Product Design*, Department of Industrial and Manufacturing Engineering University of Rhode Island, Kingston, RI, March 1987.

This report is one in a series of over 20 research papers describing topics such as robot assembly, expert systems in design for assembly (DFA) printed circuit board DFA, injection molding, laminated fibrous/epoxy, composite structures, and CAD for multi-stage cold forging.

Boothroyd Dewhurst Inc., *Design for Assembly Handbook*, Wakefield, 1985.

This is a design for assembly handbook.

Box, George E. P., "Evolutionary Operation: A Method for Increasing Industrial Productivity," *Applied Statistics*, June 1957.

The author describes a method that can be used on the shop floor to allow production systems to evolve, through observation and experimentation so that productivity is continually improved.

Box, George E. P., William G. Hunter, and J. Stuart Hunter, *Statistics for Experimenters*, John Wiley & Sons, New York, 1978.

This is a textbook and reference for design, data analysis, and model building using statistical design of experiments.

Box, George E. P. and Norman R. Draper, *Empirical Model-Building and Response Surfaces*, John Wiley & Sons, New York, 1987.

The authors provide an explanation of the use of response surfaces as a technique for analyzing and interpreting experimental data.

Box, George E. P., "Signal-to-Noise Ratios, Performance Criteria, and Transformations," *Technometrics*, vol. 30, No. 1, pp. 1-40, American Statistical Association and the American Society for Quality Control, February 1988.

The author provides an analysis of Taguchi's performance criteria, "signal-to-noise" ratio along with a more general approach called *lambda plots*. The author argues that improvement of quality will best be catalyzed by engineers using elementary data analysis with computer graphics rather than by those trained to employ more rigid predecided criteria. Includes five sets of commentary by Anne C. Shoemaker, Kwok-Leung Tsui, and Ramon V. Leon; William C. Parr; Raymond J. Carroll; Neil R. Ullman; and the author, Box.

Box, George E. P., Søren Bisgaard, and Conrad Fung, "An Explanation and Critique of Taguchi's Contributions to Quality Engineering," *Research Reports of the University of Wisconsin-Madison, Center for Quality and Productivity Improvement*, March 1988.

One of a series of research reports by the authors, who are members of the Center for Quality and Productivity Improvement at the University of Wisconsin-Madison. Other reports include "Doing More With Less in the Public Sector: A Progress Report from Madison, Wisconsin," "The Scientific Context of Quality Improvement," and "The Quality Detective: A Case Study."

Box, George E. P., *When Murphy Speaks-Listen*, Center for Quality and Productivity Improvement, University of Wisconsin-Madison, Report No. 34, Madison, WI, February 1989.

Referring to the Murphy of "Murphy's Laws" the author provides a discussion of the need to listen to a process. If there is an error or bug in the process, Murphy guarantees that its symptoms will become evident. The clever operator will listen to Murphy and improve the process. (Murphy's Laws are a collection of observations attesting to the fact that anything which can go wrong will eventually go wrong.)

Carrie, A. S., "Group Technology: Part Family Formation and Machine Grouping Techniques," *MAPEC Project*, Purdue University, 1978.

The author discusses the connection between part families and the arrangement of machines to fabricate the parts of a family.

Christiansen, Donald, *Engineering Excellence Cultural and Organizational Factors*, IEEE Press, New York, 1987.

This is a collection of essays organized by four parts: the importance of the individual engineer, a comparison of engineering cultures, institutional and organizational factors, and home and abroad.

Copp, Richard, *Report on Japanese Quality Engineering Using Designed Experiments-The Taguchi Method*, American Supplier Institute, Dearborn, MI, July, 1984.

The author describes the Taguchi approach and says it differs for the U.S. approach because instead of attempting to reduce variation, it seeks to reduce the effects of variation.

Costello, Robert B., *Bolstering Defense Industrial Competitiveness: Preserving our Heritage-The Industrial Base Securing Our Future Report to the Secretary of Defense by the Under Secretary of Defense (Acquisition)*, Department of Defense, Washington, DC, July 1988.

The author presents the results of an examination of the problems facing the defense manufacturing base. Concludes that cooperation is an essential foundation to meeting and sustaining defense goals. Six strategic thrusts are identified: (1) forging the right relations with industry; (2) improving the acquisition system; (3) establishing defense industrial strategic plans that support military strategic plans; (4) developing manufacturing capabilities concurrent with the development of weapons systems; (5) laying the foundation now for the technical skill base required for tomorrow's defense needs; and (6) ensuring that industrial base issues important to defense benefit from a full spectrum of potential remedies.

Crosby, Philip P., *Quality is Free-The Art of Making Quality Certain*, New American Library, New York, 1979.

The author asserts that there is no reason not to do things right the first time. He shows that, contrary to previously held beliefs, better quality is not more expensive. Because of the lower costs associated with better quality, viz. less rework, scrap and repair, improved quality produces significant savings.

DARPA, *Workshop on Concurrent Design, Key West, FL*, DARPA, Washington, DC, December 1-3, 1987.

This is a collection of briefings and discussions about concurrent engineering research and applications in government and industry.

David, A. J. and et al., *Quality by Design: A Quality Manual for the AT&T R&D Community*, AT&T Bell Laboratories Quality Assurance Center, Holmdel, NJ, 1987.

This manual is designed to be used by project managers, production definition and system engineering, design, implementation, test and qualification, deployment, administra-

tive systems, and research/exploratory development. It suggests how the basic techniques of quality assurance can be applied in each of the above phases to define, monitor, control, and the appropriate process so as to improve the quality of the system.

Davis, Ruth and et al., *Industrial Insights on the DoD Concurrent Engineering Program*. The Pymatuning Group, Rosslyn, VA, October 1988.

The authors provide an analysis, from the perspective of senior managers, of the recent DoD involvement in concurrent engineering.

Defense Science Board, "Nation of Japan's Industrial and Technology Direction--Annex A," *The Defense Industrial and Technological Base*, Defense Science Board 1988 Summer Study Task Force, 20 July 1988.

This report was prepared for the DSB by experienced professionals based in Japan. Intended to be objective, it also focuses on information processing and related technology. Based on assessments of MITI 2000 it gives a view of part of the Japanese plan for the year 2000 and beyond.

Deming, W. Edwards, *Out of the Crisis*, MIT Press, Boston, MA, 1986.

This is a description of the Deming management philosophy. The author explains the 14 points.

Department of Defense, *Military Standard: Data Item Descriptions (DIDs), Preparation of DOD-STD-963A*, Department of Defense, Washington, DC, 15 August 1986.

This instruction provides procedures for preparing DIDs.

Dewhurst, P. and G. Boothroyd, "Design for Assembly in Action," *Assembly Engineering*, Hitchcock Publishing Company, January 1987.

This article describes how design for assembly was used on the IBM Proprinter. Part count reduction, assembly time reduction, cost benefits are discussed. The authors also compare automated versus manual assembly.

Dorghman, M. A., *International Journal of Computer Applications in Technology*, vol. Volume 1, Nos. 1/2, Inderscience Enterprises Ltd., Coventry, UK, 1988.

The initial issue of this journal included articles on INCCA (The International Network of Centers for Computing Applications), developments in computer and communication technologies, electronic data interchange methodologies, linking manufacturing complexity to choices in computer-integrated-manufacturing (CIM), user interface design for CIM, management control in a distributed system, expert systems, geometric modelling systems, and numerical and experimental analysis of the residual stresses in welding processes.

Dornfield, David A., "Advances in Manufacturing Systems Integration and Processes," *Conference Proceedings, 15th Conference on Production Research and Technology*, Society of Manufacturing Engineers, Dearborn, MI, January 9-13, 1989.

This document contains over 80 papers organized as follows: machine tools and robotics; sensors and controls; cutting and grinding; assembly and fixtures; forming; casting; welding; CAD/CAM; systems management; and composites and plastics.

Easton, George, Harry V. Roberts, and George C. Tiao, "Conference Report: Making Statistics More Effective in Schools of Business," *Journal of Business & Economic Statistics*, vol. Vol. 6, No. 2, pp. 247-260, April 1988.

The author presents a detailed report of a conference to address the statistics curriculum in business schools. There were six workshops: curriculum-industry perspectives; curriculum-basic statistics courses; quality control, quality and productivity improve-

ment; statistical computing and graphics; forecasting and time-series analysis; and interaction of statisticians and researchers in finance, accounting, and marketing.

Feher, Bela and Mark F. Levine, *Organization Redesign for Productivity Improvement: Method and Case Study*, Navy Personnel Research and Development Center, San Diego, CA, October 1985.

This report presents the theory, principles, and methods of sociotechnical system analysis and design. A case study of an organization redesign project in a Navy ship repair organization is used to illustrate the concepts.

Feigenbaum, Armand V., *Total Quality Control*, McGraw-Hill Book Company, New York, 1983.

One of the first authors to use the term Total Quality Control, Feigenbaum argues for a more comprehensive approach to improving quality.

Ford Motor Company, *Supplier Symposium on Taguchi Methods*, American Supplier Institute, Detroit, MI, April 10, 1984.

This document presents the proceedings of the first symposium on Taguchi methods.

Ford Motor Company, *Second Supplier Symposium on Taguchi Methods*, American Supplier Institute, Detroit, MI, November 20, 1984.

This document presents the proceedings of the second symposium on Taguchi methods.

Fox, Mark S., *First Annual Conference: Center for Integrated Manufacturing Decision Systems*, Carnegie Mellon University, Pittsburg, PA, January 1989.

The conference proceedings provide a discussion of the elements of a manufacturing system architecture: design fusion, production planning, automated craftsman, factory scheduling, system control and diagnosis, and manufacturing logistics.

Freeman, Nancy Brooke, "Harley-Davidson's Race for Survival," *American Machinist*, pp. 71-75, January 1985.

The author describes Harley-Davidson's kanban-type approach, employee involvement program, and statistical process control that helped it to respond to foreign competition.

Gager, Russ, "Designing for Productivity Saves Millions," *Appliance Manufacturer*, Cahners Publishing Company, January 1986.

The author describes how decisions during design can save millions during assembly and production. Several examples are cited and the rules of design for assembly are listed.

Gallagher, C. C. and W. A. Knight, *Group Technology*, Butterworth and Co., London, 1973.

This work is contained in a recommended reading list for an advanced manufacturing curriculum at Auburn University.

Gansler, Jacques S., "Integrating Civilian and Military Industry," *Issues in Science and Technology*, pp. 68-73, Fall 1988.

The author argues for greater integration of military and civilian technologies at the engineering and production levels. He recommends five steps for DoD: (1) issue a specific policy statement; (2) identify and reduce existing barriers to integration; (3) develop a long-range strategy; (4) initiate a series of demonstration programs to work out many of the obstacles; and (5) assign specific organizational responsibilities.

Garvin, David A., "Competing on the Eight Dimensions of Quality," *Harvard Business Review*, pp. 101-109, November-December 1987.

The author describes eight dimensions of quality: performance, features, reliability, con-

formance, durability, serviceability, aesthetics, and perceived quality. He asserts that a company's challenge is to discover which dimensions of quality are most important for its business and product and to pursue those dimensions.

Garvin, David A., *Managing Quality*, The Free Press, New York, 1988.

The author provides an explication of the facets of quality and their role in the success of a company. This book presents one of the most detailed discussions of the different meanings of quality.

Garvin, David A., *Managing Quality--The Strategic and Competitive Edge*, The Free Press, New York, 1988.

The author provides an excellent treatment of the different definitions and dimensions of quality. A detailed case study drawn from the room air conditioner manufacturing industry is used to illustrate the author's views.

Gomory, Ralph E. and Harold T. Shapiro, "A Dialogue on Competitiveness," *Issues in Science and Technology*, pp. 36-42, Summer 1988.

This article is an edited transcript of the authors' discussion. A senior vice president for science and technology at IBM and president of Princeton University, they both lobby for greater directness, simplicity, and realism. They discuss the relationship between industry and the university and they agree that science and math aren't necessarily for everyone, but that basic literacy is a prerequisite for any advances.

Haas, Elizabeth A., "Breakthrough Manufacturing," *Harvard Business Review*, pp. 75-81, March-April 1987.

The author identifies the need for strategic focus. Instead of asking "How can we do it better?" we should ask "How can we beat the competition?" She discusses eight kinds of decisions: product design, process design, facility and plant configuration, information and control systems, human resources, research and development, suppliers' roles and relationships, organization.

Hahn, Gerald J., "The Coefficient of Determination Exposed!," *Chemical Technology*, vol. 3, No. 10, pp. 609-612, American Chemical Society, October 1973.

The author points out the problems of using R^2 to determine the goodness of a regression equation.

Hahn, Gerald J., "Don't Let Statistical Significance Fool You!," *Chemtech*, pp. 16-18, January 1974.

The author's column "Random Samplings" in CHEMTECH is a vehicle for providing practical advice on the uses and limits of statistics. Other columns appear in CEMTECH issues in June and September of 1974, January, March, August, and September of 1975, February, March, May, August, and November of 1976, February, September, and October of 1977, March, May, and November of 1978, January, May, and August of 1979, January and June of 1980, February and March of 1981, May and December of 1982, May 1983, November 1984, March 1985, and July and June of 1987.

Hahn, Gerald J., "Some Things Engineers Should Know About Experimental Design," *Journal of Quality Technology*, vol. 9, No. 1, pp. 13-20, January 1977.

The author discusses basic considerations and practical aspects of designing and experiment.

Hahn, Gerald J., "Experimental Design in the Complex World," *Technometrics*, vol. 26, No. 1, pp. 19-31, February 1984.

The author discusses considerations other than selecting a matrix of experimental points

and analyzing the results.

Hall, Robert W., *Kawasaki U.S.A.: Transferring Japanese Production Methods to the United States-A Case Study*, American Production and Inventory Control Society, Inc., 1982.

This case study describes Dennis Butt's program to convert American job-shop type factory into a Japanese fast-flow factory.

Harrington, H. James, *Excellence-the IBM Way*, ASQC Quality Press, Milwaukee, 1988.

The author describes the techniques used at IBM to treat white collar tasks as processes that can become the subject of systematic quality improvement efforts.

Hauser, John R. and Don Clausing, "The House of Quality," *Harvard Business Review*, pp. 63-73, May-June 1988.

The authors describe the Quality Function Deployment (QFD) approach to subsystem design.

Hayes, Robert H., Steven C. Wheelwright, and Kim B. Clark, *Dynamic Manufacturing*, The Free Press, New York, 1988.

The authors present case studies that demonstrate the need for changes in manufacturing. Comprehensive coverage includes discussion of factors affecting management decisions to improve.

Hunter, J. Stuart, "The Technology of Quality," *RCA Engineer*, vol. 30-3, pp. 8-15, RCA Corporation, Princeton, NJ, May/June 1985.

The production of information-laden data is essential to the improvement of both product quality and process efficiency. The classical histogram and Shewhart chart are but two of many graphical devices for the study of historical data to secure quality improvement information. New information is also created through process and product design experimentation. Statistically designed experiments provide for the study of the influences of several factors varied simultaneously and can be used to "block" unwanted sources of variability. The language and tools of statistics are essential components to any learning process that involves the use of measurements. Industrial competitiveness requires the application of statistics in all of its modern modes.

Hunter, J. Stuart, "The Exponentially Weighted Moving Average," *Quality Technology*, vol. 18, No. 4, pp. 204-210, October 1986.

The author describes a technique for using data collected from a process to forecast future behavior of the process. The technique represents one of several improvements upon statistical process control techniques.

Hutchinson, Charles E. and Carol B. Muller, "Educating Engineers: In Praise of Diversity," *Issues in Science and Technology*, pp. 71-74, Summer 1988.

The authors discuss an National Research Council recommendation to have students pursue a liberal arts program during their first two years of college, and reserve the study of engineering for the last two years.

Isikawa, Kaoru, *Guide to Quality Control*, Kraus International Publications, White Plains, NY, 1982.

The author describes the seven tools of quality control. He provides a description of a system that can be understood and implemented on the shop floor. (The seven tools are sometimes referred to as the seven old tools.)

Ishikawa, Kaoru, *What is Total Quality Control? The Japanese Way*, Prentice-Hall, Inc., Englewood Cliffs, 1985.

The author presents his views on why the Japanese have been so successful at implementing a quality approach to manufacturing.

Jiang, Bernard C., J. T. Black, and R. Duraisamy, "A Review of Recent Developments in Robot Metrology," *Journal of Manufacturing Systems*, vol. 7, No. 4, pp. 339-357.

This paper provides a review of various measurement techniques, and testing methods, conditions and specifications for determining the performance of robots.

Juran, J. M., *Quality Control Handbook*, McGraw-Hill, New York, 1962.

This work is a technical reference for many quality problems.

Jurgen, Ronald K., *Computers and Manufacturing Productivity*, IEEE Press, New York, 1986.

This book is a collection of articles that originally appeared in IEEE Spectrum. The articles are organized into seven areas: Part I, Productivity; Part II, Manufacturing's role in productivity; Part III, Data driven automation; Part IV, Implementing automation; Part V, Programmable logic controllers; Part VI, Robots to the rescue; and Part VII, The interface problem.

Kackar, Raghu N., "Off-Line Quality Control, Parameter Design, and the Taguchi Method," *Journal of Quality Technology*, vol. 17, No. 4, pp. 176-209, October 1985.

This paper introduces the concepts of off-line quality control and parameter design. The author also discusses the Taguchi Method for conducting parameter design experiments.

Kackar, Raghu N., "Taguchi's Quality Philosophy: Analysis and Commentary," *Quality Progress*, pp. 21-29, December 1986.

The author presents seven points that explain the basic elements of Taguchi's quality philosophy.

Kacker, Raghu N., "Quality Planning for Service Industries," *Quality Progress*, pp. 39-42, August 1988.

The author discusses steps for applying quality improvements within the service industries.

King, Bob, *Better Designs in Half the Time: Implementing QFD Quality Function Deployment in America*, GOAL/QPC, Methuen, MA, 1987.

The author provides detailed explanation of QFD with many charts. This could serve as a workbook for QFD implementation. The author uses Yoji Akao's version of QFD.

Knight, Donald O. and Michael L. Wall, "Using Group Technology For Improving Communication And Coordination Among Teams of Workers In Manufacturing Cells," *Industrial Engineering*, vol. 21, No. 1, pp. 28-34, Institute of Industrial Engineers, Norcross, GA, January 1989.

Group technology, a technique to identify families of parts that can be manufactured by similar operations, is applied to organizing planning and control functions for teams of workers who operate cell that are organized according to group technology.

Kurokawa, Kaneyuki, "Quality and Innovation," *IEEE Circuits and Devices*, pp. 3-8, July 1988.

The author points out the importance of communication with the customer and within an organization. Two concepts should govern the modern innovator: experimenting with real customers and graceful growth.

Kusaba, Ikuro, "Statistical Methods in Japanese Quality Control," *Societas Qualitatis*, vol. 2, No. 2, Union of Japanese Scientists and Engineers, May/June 1988.

The author reports methods and techniques whose use was reported at the Japanese quality circle conference. Author alludes to lack of reported use of Taguchi methods.

Landwehr, James M and Ann E. Watkins, *Exploring Data*, Dale Seymour Publications, Palo Alto, CA, 1987.

This book was prepared to help improve statistical literacy among junior- and senior-high students. The authors were guided by five principles: (1) There is often more than one way to approach problems in probability and statistics. (2) Real data should be used whenever possible. (3) Traditional topics taught in introductory statistics should be taught *after* the more basic ideas are understood. (4) The emphasis should be on good examples and teaching intuition. (5) Students enjoy and profit from project work and activities designed to give them practical experience in statistics.

Leon, Ramon V., Anne C. Shoemaker, and Raghu N. Kacker, "Performance Measures Independent of Adjustment: An Explanation and Extension of Taguchi's Signal-to-Noise Ratios," *Technometrics*, vol. 29, No. 3, pp. 253-285, American Statistical Association, August 1987.

The authors present an analysis of Taguchi's signal-to-noise ratios including an explanation of when their use is justified and when it isn't. They introduce a term, performance measurement independent of adjustment (PerMLA), to replace S/N ratios.

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This two-volume requirements document describes the desired features of an Engineering Information System (EIS).

Marquardt, Donald W., "New Technical and Educational Directions for Managing Product Quality," *The American Statistician*, vol. 38, No. 1, pp. 8-14, February 1984.

This article explores the respective roles of business philosophy, management systems, and technology systems in attaining consistently higher product quality.

Marquardt, Donald W., "Meeting the Worldwide Quality Challenge," *Quality Progress*, pp. 34-37, August 1988.

The author traces three phases of quality awareness in the U.S. and asserts that four areas must be emphasized if U.S. industry is to succeed: commitment to excellence, international standards, supplier and customer partnerships, and improved candidness of communication.

Merchant, M. Eugene, *A Report to the National Science Foundation on Research Priorities for Proposed NSF Strategic Manufacturing Research Initiative*, National Science Foundation, Washington, DC, March 11-12, 1987.

The author describes a workshop where research priorities for NSF program were established. He presents the method used and lists 16 research topics in 6 broad areas.

Monden, Yasuhiro, *Toyota Production System*, Industrial Engineering and Management Press, Norcross, GA, 1983.

The author provides a detailed tutorial of the Toyota system, including Kanban.

Monden, Yasuhiro and et al., *Innovations in Management-The Japanese Corporation*, Industrial Engineering and Management Press, Norcross, GA, 1985.

This collection of articles describes Japanese management philosophy, strategies, organizational behavior, management control systems, Japanese human-resources management,

production management, total productive maintenance, factory automation, R&D, Japanese production management abroad, financial management, marketing, and foreign direct investment.

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This collection of papers describes "Just in time" production systems in Japan and in the U.S. and total quality control, total cost reduction, and total productive maintenance.

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The author provides an introductory overview of the use of experiment design techniques to improve the quality and cost characteristics of products. The author discusses briefly some of the main design of experiment techniques.

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Based on a master's thesis at MIT, this paper describes how Ford Motor Company, Davidson Rubber, AT&T, Xerox, and ITT adopted some of the Taguchi methods.

Nazaret, William A. and William Klingler, *Tuning Computer Systems for Maximum Performance: A Statistical Approach*.

The authors discuss the use of statistically designed experiments to improve the performance of the UNIX operating system on an AT&T Bell Laboratories computer.

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This planning document describes the most important research topics for the National Center for Manufacturing Science.

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This report is one in a series concerned with the development, exploration, and generalization of a technique to increase individual motivation and productivity. The technique relies on applying behavioral science principles in what is termed a performance contingent reward system. The study evaluates the performance of small purchase buyers and supply clerks. The authors try to determine whether that performance would be enhanced by a PCRS.

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This book contains a translation of a series of lectures about the Toyota Gosei management philosophy and techniques. It includes a question and answer discussion of key topics.

Nussbaum, Bruce, "Smart Design, Quality is the New Style," *Business Week*, p. 102, April 11, 1988.

The author describes the trend towards including user and manufacturer considerations in design.

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The study provides examples of excellence in the commercial sector and makes recom-

mentations about how to apply similar methods within the Department of Defense.

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The author introduces the CUSUM chart, a technique that provides an alternative method of recording observations that helps to identify changes in a process mean.

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The authors applied Taguchi techniques to systematically and efficiently optimize a system's performance under a specified range of load and environmental conditions. The system was a VAX 11-780 machine under UNIX SystemV Release 5.0 operation.

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The authors present an argument that the newer management techniques such as just-in-time and continuous improvement (Kaizen) are really a counterproductive form of management by stress and are actually methods for extracting "free" work out of the worker.

Pennar, Karen, "The Productivity Paradox," *Business Week*, pp. 100-102, June 6, 1988.

This is one of several articles in a special issue of Business Week that discussed productivity problems.

Pennell, James P., Len Haynes, and John Salasin, "A Proposed Architecture for Integrated Diagnostics," Presented at IEEE AUTOTESTCON 1988, October 1988.

The authors present an information architecture to support the integration of diagnostic concerns in the product realization process.

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The author provides an overview of TQM, its key concepts, role in a competitive strategy, and the changes needed to practice it.

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The authors describe the application of design of experiments to a photolithography problem that resulted in a fourfold reduction in processing variation, a threefold reduction in fatal defects, and a twofold reduction in processing time.

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This article examines some of the problems with accounting systems that are used today, how they measure and track the wrong parameters, and lead to the wrong investment and expenditure decisions.

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The author gives a description of a technique for comparing different concepts at the early design stage.

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The author provides an easy-to-understand, comprehensive discussion of the Taguchi approach to quality engineering. Beginning with a review of the concept of robust design, the book provides clear examples of the application of the principles of quality loss, quadratic loss, noise factors, exploiting nonlinearity, matrix experiments. This is one of the clearest books for someone who is interested in using the Taguchi approach for achieving robust design.

Riedel, James A. and et al., *Designing a Group Wage Incentive System for Shipyard Production Employees*, Navy Personnel Research and Development Center, San Diego, CA, May 1987.

This report describes the process and results of designing a group wage incentive system for production workers at a naval shipyard. The system provides periodic cash awards to groups of civil-service workers performing above the standard. Key features of the organizational setting that were considered in the design of these systems are discussed.

Rohlen, Thomas P., "Why Japanese Education Works," *Harvard Business Review*, pp. 42-47, September-October 1987.

The author reviews two books about Japanese education: *The Japanese School: Lessons for Industrial America*, by Benjamin Duke, Praeger, 1986; and *The Japanese Educational Challenge: A Commitment to Children*, by Merry White, Free Press, 1987. The reviewer notes that both books show superb human resources are the foundation of Japanese success and those resources are the product of an educational system which reflects Japan's commitment to learning.

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This handbook is designed to help program managers ensure that concerns for diagnostic capabilities of weapons systems are addressed early in the development cycle.

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This is a collection of papers from researchers in UK describing a CAD overview, circuit simulation, logic simulation, testing, autolayout, symbolic design of VLSI circuits, IC layout verification, high-level design languages, PLA design tools, silicon compilation, CAD systems, data management, and verification of systems.

Schmidt, Stephen R. and Roger Launsby, *Understanding Industrial Designed Experiments*, CQD Ltd. Printing, Longmont, CO, 1988.

The authors designed a handbook for the engineer who has decided to start using orthogonal or nearly orthogonal experimental designs.

Schonberger, R. J., *Japanese Manufacturing Techniques*, The Free Press, 1982.

This book is recommended as part of the reading list for the Auburn University advanced program in manufacturing sciences.

Schonberger, Richard J., *World Class Manufacturing*, Free Press, New York, 1987.

The author presents an overview of Japanese manufacturing techniques and American examples of just-in-time (JIT) manufacturing.

Schreiber, Rita R., "Design for Assembly," *Robotics Today*, pp. 45-46, June 1985.

The author relates the view of Gordon Lewis, engineering consultant at Xerox, including his view of the need for a two-stage process: developing a set of principles to aid the product development team and the formation of a design for assembly team to evaluate the design and point out improvements.

Scott, Bruce R. and et. al., "Competitiveness: 23 Leaders Speak Out," *Harvard Business Review*, pp. 106-123, July-August 1987.

This article provides responses to an HBR survey on competitiveness.

Seifert, Laurence C., "Design and Analysis of Integrated Electronics Manufacturing Systems," *Design and Analysis of Integrated Manufacturing Systems*, pp. 12-33, National Academy Press, 1988.

The author describes AT&T efforts to improve quality and productivity at Oklahoma City and Denver locations.

Sepehri, Mehran, *Quest for Quality: Managing the Total System*, Industrial Engineering and Management Press, Atlanta, GA, 1987.

This is a collection of articles with chapters entitled, "Toward World Class Quality," "Defining Quality," "Managing Quality," "Education," "Training and Quality Circles," "Tools," "The Service Sector," "Cost," "Quality Through Automation," "Software," and "Case Studies."

Sequin, Carlo H., "Managing VLSI Complexity: An Outlook," *Proceedings of the IEEE*, vol. No. 1, pp. 149-166, IEEE, January 1983.

The author examines the nature of complexity of VLSI circuits and shows similarity with large software engineering problems.

Shingo, S., *A Revolution in Manufacturing: The SMED System*, Productivity Press, 1985.

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Shoemaker, Anne C. and Raghu N. Kacker, "A Methodology for Planning Experiments in Robust Product and Process Design," *Quality and Reliability Engineering International*, vol. 4, pp. 95-113, John Wiley & Sons, 1988.

The authors describe a four-step method for implementing robust design: (1) formulate the problem by stating the objectives and then listing and classifying product and process variables; (2) plan an experiment to study these variables; (3) identify improved settings of controllable variables from the experiment's results; and (4) confirm the improvement with a small follow-up experiment.

Snee, Ronald D., "Experimenting with Mixtures," *Chemtech*, vol. 9, pp. 702-710, November 1979.

The author discusses design of experiments for mixture problems and shows that the factorial design is not suitable for this situation. He describes the simplex approach and gives examples of different models for fitting a response surface.

Snee, Ronald D., "Graphical Analysis of Process Variation Studies," *Journal of Quality Technology*, vol. 15, No. 2, pp. 76-88, April 1983.

Graphical procedures for analyzing the results of nested sampling studies are presented and illustrated with examples. It is shown that a standard deviation control chart analysis will detect atypical results and nonhomogeneous variances that can greatly distort the estimated process variance components. The procedure enables the quality engineer to see the sources and magnitude of the variation in the process and to identify any unusual characteristics of the data.

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This collection of papers on industrial experiments from Swift and Company, E.I. du Pont de Nemours and Company, Manville Corporation, General Electric, Rutgers University, Environmental Protection Agency, Thomas J. Lipton Inc., United States Steel, Procter and Gamble, and Colorado State University gives many examples of statistical experiments in practical applications.

Snee, Ronald D., "Computer-Aided Design of Experiments--Some Practical Experiences," *Journal of Quality Technology*, vol. 17, No. 4, pp. 222-236, October 1985.

The author describes uses of computers to administer experimental programs and to develop experimental plans for situations where classical methods are not applicable. Several examples are presented.

Snodgrass, Thomas J. and Muthiah Kase, *Function Analysis: The Stepping Stones to Good Value*, Board of Regents--University of Wisconsin System, Madison, WI, 1986.

The authors provide a description of the FAST function analysis system technique including technical FAST, Task/Customer FAST, and function cost allocation as part of Value Engineering. There are some similarities in the goals of FAST and QFD but the implementations are different. At least one practitioner found them complementary.

Sullivan, L. P., "Quality Function Deployment," *Quality Progress*, pp. 39-50, June 1986.

The author provides an introduction to QFD.

Suzaki, Kiyoshi, *The New Manufacturing Challenge*, The Free Press, 1987.

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Taguchi, G. and S. Konishi, *Orthogonal Arrays and Linear Graphs*, American Supplier Institute, Dearborn, MI, 1987.

This booklet contains the most commonly used orthogonal arrays and their associated linear graphs.

Taguchi, Genichi and Yuin Wu, *Introduction to Off-Line Quality Control*, Central Japan Quality Control Association, February 1, 1985.

This tutorial is available from the American Supplier Institute, Dearborn, MI. As the title suggests, it is an introduction to the quality philosophy of Genichi Taguchi.

Taguchi, Genichi, *Introduction to Quality Engineering*, American Supplier Institute, Dearborn, MI, 1986.

This is another introductory text on Taguchi's quality engineering methods.

Taguchi, Genichi, *System of Experimental Design*, American Supplier Institute, Detroit, MI, 1988.

Taguchi describes his recommended methods for experimental design.

Talley, Dorsey J., "New Challenges for Quality Professionals in Defense Industries," *Quality Progress*, vol. XXI, Number 12, pp. 41-43, ASQC, Milwaukee, December 1988.

The author, a division vice president for quality assurance with General Dynamics discusses the DoD quality excellence program, the concerns of industry, and the objectives for quality professionals. He mentions the DoD Ten Point Excellence Program and describes how General Dynamics is responding to the challenges of the program. The author pays particular attention to specification streamlining, new specifications and clauses (e.g., AVIP) new interpretations (a cause for concern), and the role of audits as cost drivers.

Tribus, Myron, *Quality First: Selected Papers on Quality and Productivity Improvement*, National Society of Professional Engineers, Washington, DC, March 1988.

The author presents fifteen essays on productivity, competitiveness, management, Deming management philosophy, and quality.

Tribus, Myron, "Changing the Corporate Culture Some Rules and Tools," Presented to the Philadelphia Area Council on Excellence, Valley Forge, PA, October 17, 1988

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Tsui, Kwok-Leung, "Strategies for Planning Experiments Using Orthogonal Arrays and Confounding Tables," *Quality and Reliability Engineering International*, vol. 4, pp. 113-122, John Wiley & Sons, January 1988.

The author presents a new set of tools, "confounding tables" for use by experimenters when planning experiments. The tables are compared with Taguchi's linear graphs.

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This document describes R&M 2000 goals, principles, and building blocks to increase combat capability while saving resources through good R&M practices.

Wheeler, Donald J. and David S. Chambers, *Understanding Statistical Process Control*, Statistical Process Controls Inc., Knoxville, TN, 1986.

The authors provide a tutorial on how to set up control charts for various situations.

Whitney, Daniel E. and et al., "The Strategic Approach to Product Design," *Design and Analysis of Integrated Manufacturing Systems*, pp. 200-223, National Academy Press, Washington, DC, 1988.

The authors describe a concurrent design approach developed at Draper Labs that focuses on the assembly process.

Willoughby, W. J., *Best Practices: How to Avoid Surprises in the World's Most Complicated Technical Environment*, Department of the Navy, Washington, DC, March 1986.

This is a supplement to DOD 4245.7 that enhances the enlightenment of industry and government by identifying specific practices in current use and their potential adverse consequences in terms of cost, schedule, performance, and readiness. It then describes the proven best practices which avoid or alleviate these consequences and provides enough background rationale to understand them.

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This report documents the results of an IDA study on concurrent engineering and provides recommendations for a DOD policy to include concurrent engineering in the acquisition process.

Wolfe, Robert, "Solid Modeling for Production Design," *IBM Journal of R&D*, IBM, Yorktown Heights, May 1987.

The author describes use of solid modeling for both mechanical and semiconductor design and evaluation. He describes a system for mechanical applications and one for semiconductor applications.

Woodward, R. H. and P. L. Foldsmith, *Cumulative Sum Techniques*, Oliver & Boyd, London, 1964.

The authors describe and explain cumulative sum (CUSUM) techniques.

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