1997

This bibliography covers a range of topics, from research on teaching and learning through design experiences in K-12 classrooms to the application of learning theory to design problem solving in a broad range of contexts. In references that support pedagogical research in the application of design thinking and concepts to K-12 classrooms, the goal is to enhance learning and teaching in all subjects, not to provide pre-professional or vocational training in design. Emphasis is placed on the consistency between what is called for in national education reform initiatives and the learning outcomes of a design education. In the selection of references on learning theory and cognition, there is an assumption that "preferences for ways to learn" are congruent with "preferences for ways to access information." Therefore, the concepts explored in these books have direct implications for the design of information in any context or for any audience.

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EDUCATIONAL REFORM

The descriptive and analytical research in these books strengthens the position of reform initiatives in K-12 schools and teacher education intended to guide the US in meeting the economic, technological, political, cultural, and social challenges of the next century. Common to most studies in this section is the call for students to be: flexible thinkers, creative problem solvers, competent communicators, and active participants in their communities. Some studies go as far as to cite design experiences or thinking as integral to the understanding of their relative subjects. Also included in this section are national standards for various subject areas that have been developed through a consensus-building process in response to reform research. Practical strategies for achieving these standards form an important area of research. Designers hoping to have an impact on how schools teach and what children learn should become familiar with this material as it defines the political and social climate in which educators work.

American Association for the Advancement of Science, Project 2061, **Benchmarks for Science Literacy.**
New York: Oxford University Press, 1993
This study describes the role of science and technology in addressing the radical changes expected with the next human life span. It also proposes what the substance and character of an education designed to meet those challenges will be. More forward-thinking and demanding of creativity than the *National Standards for Art Education*, this publication serves as an innovative road map for those wishing to build a case for the use of design in mainstream instruction. The sections on technology are especially relevant to product design. The publication also provides ample justification for future research into appropriate pedagogies for delivering such an education.

Center for Civic Education, **National Standards for Civics and Government**
Calabasas, California: Center for Civic Education, 1994
These standards call for increased involvement of students in the social and political processes of their communities. A good argument for the adoption of curricula that include design experiences in which children analyze real problems and propose solutions. The standards hold particular significance for architects and environmental designers with an interest in pedagogical strategies for K-12 classrooms.

Consortium of National Art Education Associations, **National Standards for Art Education: What Every Young American Should Know and Be Able to Do in the Arts**
Reston, Virginia: Music Educators National Conference, 1994
Disappointingly, these standards describing what every child should know and be able to do in dance, music, theatre, and the visual arts intentionally avoid descriptions that relate to design. The authors viewed design as simply another sub-specialty of the visual arts, not as as a process with specific thinking skills or content that differ from the fine arts. The subsequent framework for the *National Assessment of Educational Progress in the Arts*, attempted to address these differences by including specific performance standards for design.

Holmes Group, **Tomorrow's Schools of Education**
East Lansing, Michigan: Holmes Group, 1995
The Holmes Group, a consortium of universities doing educational research and educator preparation, published this self-critical report on higher education that calls for educators to "adopt the reforms that link their educational contributions closely with improved schooling...or surrender their franchise." The reforms cited as necessary in teacher preparation argue in favor of exposing college education majors to experiences much like those of design students. This publication is excellent background reading for those who wish to build strong alliances between schools of education and schools of design.

National Assessment Governing Board, **NAEP Arts Education Consensus Project, Arts Education Assessment Framework**
Washington, DC: Chief State School Officers with the College Board and the Council for Basic Education, 1994
This is the first US performance-based assessment of the visual arts (in which students actually make art and solve design problems) in twenty years and the first to include design as a discrete area of performance. The framework outlines the content and achievement standards against which the national assessment was developed. While the final test suffers from the inevitable tradeoffs in mounting a national exam for more than 40,000 students, the framework is a useful articulation of what students should know and be able to do in design.

National Commission on Excellence in Education, **A Nation at Risk: The Imperative for Educational Reform**
Washington, DC: US Government Printing Office, 1983.
This landmark report launched the US on its quest for educational reform. Highly critical of what American children know and are able to do, the report serves as a benchmark for the reform movement.

National Council of Teachers of English and International Reading Association, **Standards for the English Language Arts**
Urbana, Illinois and Newark, Delaware: National Council of Teachers of English and International Reading Association, 1996
Although some of the more obvious connections to design were lost between early versions and the final draft, these standards clearly advocate children learning to "read" visual information (maps, charts, diagrams) as well as the written word. Further, the authors seem to see a connection between imaginative writing and thinking visually.

National Council for the Social Studies, **Expectations of Excellence, Curriculum Standards for Social Studies**
Washington, DC: National Council for the Social Studies, 1994
These national standards for social studies include frequent reference to student proficiency in creating graphic communications and learning to derive and analyze information from maps, charts, tables, and other graphic information.

National Research Council and National Academy of Sciences, **National Science Education Standards**
Washington, DC: National Academy Press, 1996
As in other subject areas, these standards were defined for grades K-12 through a national consensus-building process. They represent significant change toward the perception of science education as creative problem solving and application. The section on technology education encourages designing as well as using technology. The word "design" appears throughout these standards.

New Standards Project, **Performance Standards in English Language Arts, Mathematics, Science, and Applied Learning**
Washington, DC: National Center on Education and the Economy, 1997
Led by Lauren Resnick at the Learning Research and Development Center of the University of Pittsburgh, the New Standards Project attempts to build an assessment system to measure student progress in meeting national content and performance standards in various subject areas. Of special interest to designers is a non-disciplinary category of standards titled "Applied Learning" that cites skills and knowledge common to design and that assesses student performance through design tasks.

United States Department of Labor, The Secretary's Commission on Achieving Necessary Skills, **Skills and Tasks for Jobs: A SCANS Report for America 2000**
Washington, DC: 1992
This report cites the key worker competencies, skills, and qualities necessary in the workforce of the next century. These competencies and thinking skills bear striking resemblance to the learning outcomes of a design education (problem solving, creative thinking, seeing things in the mind's eye, understanding systems, interpreting and communicating information, etc.) and argue effectively for the inclusion of design-based instruction in all schools.

TEACHING AND LEARNING THROUGH DESIGN

These books provide examples of research in the use of design as a teaching and learning strategy. Also included are summaries of K-12 programs in which design serves as a model for teaching other subjects in the curriculum or enhances students' understanding of the world in which they live. Often deceptively simple in their presentation, these books result from authors' investigation into the fit between the way designers think, how children learn, and the goals of educational reform.

Bruce Archer, Ken Baynes, and Phil Roberts, **The Nature of Research into Design and Technology Education**
Loughborough, England: Loughborough University, 1992
These pioneers in the effort to establish design and technology as components of the national curriculum in the UK analyze how children think as designers and the implications for curriculum and pedagogy. After a decade of curriculum implementation and assessment, the UK provides the most comprehensive study of this subject and these three authors are among the most active researchers.

Pauline Bottrill, **Designing and Learning in the Elementary School**
Reston, Virginia: International Technology Education Association, 1995
The often confusing definitions of "technology education" become more clear in this book. Neither about learning computer software nor the old "industrial arts" model we associate with building exercises that acquaint students with power tools, this book describes an education in which invention and problem solving are paramount. Aesthetics or "style" receive little attention in this discussion, however, the fit between form and function is made clear.

Charles Burnette and Jan Norman, **DK-12: Design for Thinking**
Tucson, Arizona: Crizmac, 1997
Burnette, an industrial design professor, and Norman, his University of the Arts colleague in Art and Museum Education, have developed a description of how the design process works that can be used in K-12 classrooms. Their methods have been tested in schools and in college-level classes for art teachers and designers who hope to work in K-12 curricula.

Meredith Davis, Peter Hawley, Bernard McMullan, and Gertrude Spilka, **Design as a Catalyst for Learning**
Alexandria, VA: Association for Supervision and Curriculum Development, 1997
A report of a two-year study by the National Endowment for the Arts on the use of design in K-12 classrooms. The book explains the thirty-year history of design-based education, the relationship between design-based teaching and learning strategies and the goals of education reform, and case studies from 170 elementary and secondary teachers in all subject areas.

Susan Dunn and Rob Larson, **Design Technology: Children's Engineering**
Bristol, Pennsylvania: Falmer Press, 1990
These two authors present a compelling case for having children design technology, even in the primary grades. Their ideas are given weight by their highly successful work in using technology as the curricular core in the Oregon elementary schools where Dunn is and has been a principal.

C. Edwards, L. Gandini, G. Forman, eds., **The Hundred Languages of Children: The Reggio Emilia Approach to Early Childhood Education**
Norwood, New Jersey: Ablex Publishing Corporation, 1993
The Reggio Emilia schools in Italy use design and creative activities as the core of early childhood education. These programs have been the source of much study and the basis of traveling exhibits in the US.

John Eggleston, **Teaching Design and Technology**
Philadelphia, PA: Open University Press, 1996
A university professor of education, Eggleston has written a guidebook to curriculum development and instruction in design and technology. To American designers, the definitions of "design" and "technology" seem more arts-and-crafts-based than in the US and share much with what we once called "industrial arts". But this book presents valuable lessons in articulating the fit between such hands-on instruction and other aspects of curriculum.

Ali Farrell and Jim Patterson, **Understanding Assessment in Design and Technology**
London, England: Hodder and Stoughton, 1993
Written by the Technology Education Research Unit (TERU) at the University of London, this book provides a basic structure for developing assessments of design and technology. The framework is probably most effective for work with young children.

Ginny Graves, **Walk Around the Block**
Prairie Village, KS: Center for Understanding the Built Environment, 1997
Known for her work in K-12 education, Graves provides project examples that encourage student exploration of the built environment.

David Hyerle, **Visual Tools for Constructing Knowledge**
Alexandria, VA: Association for Supervision and Curriculum Development, 1996
Hyerle illustrates the use of brainstorming webs, task-specific organizers, and thinking process maps in organizing and communicating information in learning contexts. The author's visual techniques are as useful in design planning as they are in educational tasks and, therefore, could be applied in introductory college-level design classes.

Richard Kimbell, Kay Stables, and Richard Green, **Understanding Practice in Design and Technology**. Philadelphia, PA: Open University Press, 1996
Kimbell heads a research unit at Goldsmith's College/University of London that studies the ways designers think and the implications for education. Using the design process as a methodological model for flexible and creative thinking, Kimbell and colleagues present teaching approaches to science and technology that accommodate differences among learners and that encourage high levels of student motivation.

Doreen Nelson, **Manual for City Building Education Project**
Los Angeles, California: Center for City Building Education, 1982
Nelson, a college professor in elementary education, is among the early proponents of using environmental design activities to teach creativity and design thinking to young children. Her *City Building Education Project* is well known here and abroad and she was a consultant on the development of *SimCity*, popular software in which users make choices about the design of cities.

Doreen Nelson, **Transformations: Process and Theory**
Los Angeles, California: Center for Building Education Programs, 1984
More extensive than *Manual for City Building Education Project*, this book explores Nelson's hands-on methods and the theory of using design as a way to develop students' creative thinkin and group problem solving.

Senta Raizen, Peter Sellwood, Ron Todd, and Margaret Vickers, **Technology Education in the Classroom: Understanding the Designed World**
San Francisco, CA: Jossey-Bass Publishers, Inc., 1995
A report by the National Center for Improving Science Education, this book confirms the need for technology education through analysis of current educational practice in the US. Citing obstacles to broader application in American schools, the authors articulate a vision for curriculum and teaching strategies that involve technology. An appendix provides summary descriptions of technology education in various countries.

Royal College of Art, **Design in General Education, Part One, Summary of Findings and Recommendations**
London, England: Royal College of Art, 1976
This landmark study favored the inclusion of design in the national curriculum in Great Britain and resulted in later legislation that established design and technology instruction in all schools. It successfully argues that design experiences provide learning opportunities critical to the achievement of necessary skills.

Mario Salvadori, **Architecture and Engineering: An Illustrated Teacher's Manual on Why Buildings Stand Up**
New York: New York Academy of Sciences, 1993
One of several books by Salvadori, this one describes principles of architecture in ways that are directly applicable to science, mathematics, and technology instruction. Simple diagrams explain complex concepts. As in its counterpart, *Why Buildings Fall Down: Structure in Architecture*, such explanations are the basis of Salvadori's successful instruction at the Center for Built Environment Education.

Anna Slafer and Kevin Cahill, **Why Design?**
Chicago, IL: Chicago Review Press, 1995.
Based on projects from DesignWise, the National Building Museum's summer design curriculum for high school students, the book includes project descriptions that cross design disciplines and can be adapted to classrooms.

Anne Taylor, **Architecture and Children: Learning by Design, Teachers Guide and Poster Sets**
Albuquerque, New Mexico, American Institute of Architects, 1992
University of New Mexico architecture professor Taylor is well-known for her *Architecture and Children* program. This collection of materials defines the program and projects that acquaint students with concepts related to the built environment. Decidedly architectural in its orientation, there is little investigation of the product or graphic design concepts that also define the built environment.

David Thistlewood, ed., **Issues in Design Education**
New York: Longman, 1990
This collection of essays from mostly British researchers and design educators, explores what we mean by design, defining the place of design in curriculum, and the role of "making" in education.

Polly Welch, ed., **Strategies for Teaching Universal Design**
Boston, MA: Adaptive Environments Center, 1995
Written to inform the development of college-level design curricula, this book proves an excellent resource for introducing students of all ages to problem solving that addresses a full range of user needs. Despite far-reaching civil rights laws, schools seem unaware of the relationship between design and inclusiveness. Conceived as "curriculum interventions," the strategies in this book seem as appropriate for discussion and implementation in K-12 classrooms as in college design studios.

CURRICULUM DEVELOPMENT, PEDAGOGY, AND ASSESSMENT

These books address curricular and pedagogical strategies that support a design approach to learning as well as the goals of educational reform. In some cases, the books describe the nature of thinking and learning that develop under a design-based pedagogy. The books on assessment focus on improving students' and teachers' skills, not on broad-based reporting to government and the public.

Doug Boughton, Elliot Eisner, and Johan Ligtvoet, **Evaluating and Assessing the Visual Arts in Education: International Perspectives**
New York: Teachers College Press, 1996
A compilation of viewpoints about assessment strategies, this book provides useful information in an area most designers and artists avoid in the belief that creativity cannot be evaluated authentically.

Martin Brooks and Jacqueline Brooks, **In Search of Understanding: The Case for Constructivist Classrooms**
Alexandria, Virginia: Association for Supervision and Curriculum Development, 1993
This book describes the current thinking about interactive, integrated curriculum experiences through which children "construct" knowledge and meaning. This is in opposition to the commonly used strategies of telling students what information means through lectures and textbooks. For designers, this theory holds some relevance for developing communication strategies through which individuals must acquire new knowledge and form opinions.

Edward DeBono, **De Bono's Thinking Course**
New York: Facts on File Publications, 1985
The author describes this book as concerned with thinking that "makes for wisdom rather than the sort that makes for cleverness." It is a collection of techniques that develop lateral thinking abilities and that account for feelings and values.

Edward DeBono, **New Think: The Use of Lateral Thinking in the Generation of New Ideas**
New York, Basic Books, Inc., Publishers, 1967
DeBono discusses the difference between vertical thinking (high-probability, straight ahead) and lateral thinking (low probability, sideways) and the value of searching for more than one solution to problems. DeBono's thinking strategies have value in education as well as in design practice and this is one of his many books that address these issues.

W.J.J. Gordon, **The Metaphorical Way of Knowing and Learning**
Cambridge, MA: Porpoise Books, 1973
Easier to read than *Synectics*, this book uses case studies to illustrate the use of analogy in problem solving and in teaching complex ideas and relationships. Examples are applicable to corporate as well as educational settings and especially useful in discussing ways of presenting unfamiliar concepts to anyone.

Heidi Hayes Jacobs, **Interdisciplinary Curriculum: Design and Implementation**
Alexandria, Virginia: Association for Supervision and Curriculum Development, 1989
Jacobs is a leading proponent of interdisciplinary curricula. In this book she warns against superficial investigations that are constructed for the sake of interdisciplinarity alone. She further explains the value of the disciplines to interdisciplinary study while advocating for connected experiences that resemble the integrated problem solving demands of adult work.

Richard Kimbell, Kay Stables, Tony Wheeler, Andrew Wosniak, and Vic Kelly, **The Assessment of Performance in Design and Technology**
London, England: School Examinations and Assessment Council, 1993
A summary of the assessment of the first ten years of the design and technology curriculum in British schools, this report provides credible evidence that design learning can be assessed in ways that are convincing to school administrators and the public. The book includes ample test exercises as well as a complete explanation of rubrics and testing strategies.

David Perkins, **Smart Schools: Better Thinking and Learning for Every Child**
New York: Free Press, 1992
In this book Perkins describes smart schools as "informed, energetic, and thinking-centered." He dissects what is really meant by "understanding" and tackles the issues of metacurriculum and distributed intelligence (which runs counter to the emphasis on solo performance in most classrooms.) Perkins' description of the smart school is not far from the contemporary practice of strategic design.

David Perkins, Raymond Nickerson, and Edward E. Smith, **The Teaching of Thinking**
Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1985
Perkins and his co-authors cover various perspectives on the nature of thinking as well as practical ways to teach thinking. In a section on problem solving, creativity, and metacognition (thinking about thinking), the authors describe some creative vs. noncreative patterns of thinking as habits of information processing, not ability. In later chapters, the book cites specific studies and methods for the teaching of thinking.

Dennie Palmer Wolf, **Performance-Based Student Assessment: Challenges and Possibilities**
Chicago, Illinois: University of Chicago Press, 1996
Director of a Harvard University research unit on performance-based assessment, Wolf builds her views on assessment from research in classrooms and schools across the country. She is a strong proponent of portfolio assessment and evaluation that concerned itself more with student improvement than with reporting.

COGNITION AND LEARNING THEORY

These books cover issues related to how individuals learn, perceive and process information, and form categories of concepts that shape thought and attitudes. Some references come from education while others are written by cognitive scientists and philosophers. In the selection of these texts, there is an assumption that learning occurs in any situation in which new information or attitudes must be acquired. Such learning is not restricted to classroom settings and the research represented below can have profound relevance for the design of information in any context.

Phillip L. Ackerman, Robert J. Sternberg, and Robert Glaser, **Learning and Individual Differences: Advances in Theory and Research**
New York: W.H. Freeman and Company, 1989
A compilation of essays by various researchers, this text looks at how individuals differ in their abilities and preferences for learning and how such differences are measured. Several taxonomies of learning skills are offered and can serve as checklists for designers who care about being inclusive in their structuring and representation of information. Of special interest to designers are discussions of testing associational fluency, visual matching, space relations, visual scanning, design memory (visualizing steps in drawing a figure), visual constancy (visualizing alternate positions of the same object), and Gestalt closure. Several of the essays require some skill at reading statistical outcomes from psychological tests.

Martha Augoustinos and Iain Walker, **Social Cognition: An Integrated Introduction**
London: Sage Publications, 1995
A comprehensive survey of research in social cognition, this book examines theories of information processing with special attention to content and context. Covering topics such as attitudes, schemas, social representations, and stereotyping, the authors provide both theories and applications. The book is helpful in understanding the origins of attitudes and behavior that must be taken into account for successful communication. The citations are useful in developing a more complete bibliography on the topic and in finding seminal research.

Joan Boykoff Baron and Robert J. Sternberg, eds., **Teaching Thinking Skills**
New York: W.H. Freeman and Company,1987
This collection of essays by various authors is helpful in understanding the development of critical thinking skills in students (including college students studying design). Several essays propose taxonomies of thinking that guide strategies for structuring information in learning contexts. For designers who are as engaged in the authoring and ordering of content in complex learning situations as they are in its form, these are useful frameworks for analyzing possible learning outcomes.

Jerome Bruner, **Acts of Meaning**
Cambridge, MA: Harvard University Press, 1990
Having launched a cognitive revolution in the mid 1950s, Bruner continues his interest in what he calls "folk psychology," an alternative to the computational models of thinking so prevalent in the field. This book makes a strong case for our cognitive predisposition to narrative, to understanding and explaining the world through storytelling. Bruner describes negotiating and renegotiating meanings by the mediation of narrative interpretation and the "tool kit of interpretive techniques" passed on through culture. He traces the "entry into meaning" of young children and firmly establishes the importance of narrative to cognitive development.

Jerome Bruner, **On Knowing: Essays for the Left Hand**
Cambridge, MA: Belknap Press of Harvard University Press, 1962
Referring to the powers of intuition and emotion in the title, Bruner describes how we construct reality and how the act of knowing results in language, literature, and art. In later chapters, Bruner connects these ideas to teaching.

Jerome Bruner, Jacqueline J. Goodnow, and George A. Austin, **A Study of Thinking** (second printing)
New Brunswick, NJ: Transaction Publishers, 1990
There is consensus among historians that this book, originally published in 1956, marked the birth of contemporary cognitive science and a significant break with computational models of thinking. The book describes the task of isolating and using concepts, the relationship of concept acquisition to adapting to environment, and experiments in categorization and concept attainment.

Michael Cole, **Cultural Psychology: A Once and Future Discipline**
Cambridge, MA: Belknap Press of Harvard University Press, 1996
A cursory history of the discipline of psychology, this book ends with Cole's position that mediation through culture is "the special characteristic of human thought." In one chapter, Cole illustrates how his theories can be used to construct educational activities. Helpful in describing methodology for studying cultural/psychological phenomena.

Mihaly Csikszentmihalyi, **Beyond Boredom and Anxiety: The Experience of Play in Work and Games**
San Francisco, CA: Jossey-Bass, Inc., Publishers, 1975
Building on his notion of flow (described below), the author breaks down the roots of enjoyment and intrinsic motivation. This work can inform designers' development of communication and product strategies in which learning is a critical component.

Mihaly Csikszentmihalyi, **Flow: The Psychology of Optimal Experience**
New York: Harper and Row Publishers, 1990
The author explains the characteristics of *flow*, a mental state in which concentration is so directed that there are no distractions from the task and the experience is so gratifying that we do it for its own sake. In analyzing how such optimal experience is achieved, Csikszentmihalyi offers valuable models for designing educational and work experiences.

Elliot Eisner, ed., and the National Society for the Study of Education, **Learning and Teaching the Ways of Knowing**
Chicago: University of Chicago Press, 1985
A collection of essays by important scholars such as Rudolf Arnheim, Jerome Bruner, Robert Sternberg, Michael Cole, and Elliot Eisner, this book examines modes of knowing and the implications for educational practice. While the focus of the book is on reforming curriculum and instruction, the essays provide insight into how people learn in other than school contexts and relevant differences that could shape the presentation of information.

Howard Gardner, **Frames of Mind: The Theory of Multiple Intelligences**
New York: Basic Books, 1983
In this book Gardner introduces his theory of multiple intelligences, describing linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, and personal as the spectrum of intelligences found in any individual. Gardner uses this analytical framework to explain why certain contemporary educational efforts have achieved success while others have not. For designers, Gardner's isolation of these distinct domains raises questions about exclusively linguistic or visual strategies for presenting information.

Howard Gardner, **Multiple Intelligences**
New York,: Basic Books, 1993
Gardner's much-heralded theory of multiple intelligences (first described in *Frames of Mind* in 1983), receives a more practice-oriented treatment in this edition. Convinced that an intelligence can serve both as the content of instruction and the means or medium for communicating that content, Gardner confirms what designers already know: that we can "know" something through cognitive experiences that have their basis in sound, space, and movement as well as in words and numbers. For designers, this can provide insight into possible points of audience entry into unfamiliar subject matter.

Michael Joyce, **Of Two Minds: Hypertext Pedagogy and Poetics**
Ann Arbor: University of Michigan Press, 1995
A professor of English at Vassar and hypertext novelist, Joyce discusses new issues in writing and the teaching of writing raised by electronic technology. The author describes a shift in human consciousness in which readers choose both the order and form of what they read. For designers, this book raises questions about the structure of information and traditional formats, such as books and film.

George Lakoff, **Women, Fire, and Dangerous Things: What Categories Reveal about the Mind**
Chicago: University of Chicago Press, 1995
In a discussion of our conceptual system and how it is organized, the author suggests that we make sense of our experience by a process called "categorization" in which we group concepts according to shared properties. Among others, Lakoff cites the work of Eleanor Rosch and the notion of "prototypes" (best examples of a category). This work provides insight for the selection of objects, places, events, and words to represent ideas and emotions in visual communication.

George Lakoff and Mark Johnson, **Metaphors We Live By**
Chicago: University of Chicago Press, 1980
The authors believe metaphors are the key to explaining how we understand the world and more than poetic form and instruments of language. They suggest that our conceptual system is largely metaphorical and that metaphors actually structure our behavior and actions as well as our thought. Early chapters provide clear definitions of types of metaphors while later chapters discuss how they work in culture and in shaping experience. This reading can guide the selection of metaphorical forms used to express meaning in visual communication.

Brenda Laurel, **Computer as Theatre**
New York: Addison-Wesley Publishing Company, 1991
Trained in theatre, Laurel makes a strong case for using design principles for human-computer activity that have their roots in the performing arts and narrative. This is a refreshing discussion in the sea of writing about information architecture coming from computer scientists and organizational psychologists.

Edward and Monika Lumsdaine, **Creative Problem Solving: Thinking Skills for a Changing World**
New York: McGraw-Hill, 1995
Written to persuade engineers about the value of creative thinking to problem solving and business, most of this book is old news to designers. However, the chapter on cognitive styles is succinct in its summary of the work of Ned Herrmann, David Kolb, and Bernice McCarthy who provide useful descriptions of how audiences may differ in their preferences for thinking and ways of accessing information. It also raises important questions about the nature of teamwork that positively supports such cognitive preferences and abilities.

Bernice McCarthy, **The 4MAT System: Teaching to Learning Styles with Left/Right Mode Techniques**
South Barrington, IL: EXCEL Publishing, 1987
Written like a primer, this work is deceptively simple but builds on important learning theory research by David Kolb. The text is part of an overall testing system for determining how individuals prefer to perceive and process information. Kolb's/McCarthy's discussions of problem solving vs. problem seeking and their descriptions of four learner types hold significance for designers in the choice of representational strategies and for design educators in explaining differences of approach and critique opinion among design students.

Donald Norman, **The Design of Everyday Things** (formerly the Psychology of Everyday Things)
New York: Doubleday, 1988
This is a highly readable critique of the dysfunctional design of everyday products. Norman points out the misfit between how people think and behave and the design of common objects and environments. This is a good reminder that the criteria driving contemporary design are not always related to use.

Donald Norman, **Things that Make Us Smart**
New York: Addison-Wesley Publishing, 1993
In his conversational style, Norman describes types of cognition and the importance of representation. In particular, this book challenges representational strategies used in the design of new media.

Andrew Ortony, ed., **Metaphor and Thought** (second edition)
New York: Cambridge University Press, 1995
Editor Ortony, faculty fellow in the Institute for Learning Sciences at Northwestern University, has put together a collection of essays on the relationship between metaphor and meaning, representation, understanding, science, and education. As designers and educators frequently communicate through visual and linguistic analogies, this book offers valuable insights into how metaphors shape human thought and can guide our selection and understanding of representational form.

David Perkins, **Knowledge as Design**
Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1986
Co-director of Project Zero at Harvard University, Perkins writes on the development of thinking skills. In this volume, he emphasizes the difference between "knowledge as information" and "knowledge as design", a structure adapted to a purpose. The book ranges across subjects such as problem finding, the value of models to thinking, and argument. For designers, Perkins' lanugage provides comforting descriptions of experiences we have all had.

David Perkins,**The Mind's Best Work**
Cambridge, Massachusetts: Harvard University Press.
A combination of theory, examples, and thought problems, this book examines the nature of invention and creative and critical thought. Perkins uses the creative lives of accomplished people from the arts and sciences to illustrate his points and then goes on to recommend teaching strategies that support creative thinking.

R.M. Ryan, J.P. Connell, and E.L. Deci, **Research on Motivation in Education: The Classroom Milieu**, Volume 2 (Carole Ames and Russell Ames, eds.)
New York: Academic Press, Inc., 1995
A discussion of self-determination and self-regulation in education. The authors' findings support the notion that motivation in a learning situation will be higher when the individual maintains some control about what is learned and how it is learned. For designers, this raises questions about linear, author/designer-controlled presentations of information.

Richard E. Snow and Marshall J. Farr, eds., **Aptitude, Learning, and Instruction - Volume 3: Conative and Affective Process Analyses**
Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1987
Subjects range from intelligence and cognitive style to thinking about feelings and motivation. Of special interest is a discussion of the heuristics for designing intrinsically motivating learning environments.

Robert J. Sternberg, ed., **Handbook of Human Intelligence**
New York: Cambridge University Press, 1982
This tome of essays covers the theories on the nature of intelligence, learning, memory, reasoning and problem solving, and cutlure and intelligence. A good place to start if you are trying to determine the range of issues on the subject of intelligence.

Robert J. Sternberg and Richard K. Wagner, eds., **Mind in Context**
New York: Cambridge University Press, 1994
The preface to this collection of essays states that the editors tried to bridge the gap between constructivists, who believe all cognition depends on interaction with the outside world, and the traditional point of view that all cognition resides in the mind. Sternberg's own essay offers a model of person-context interaction and situated learning (and work) that is especially relevant to designers. Other essays address the concept of distributed intelligence.

Richard Saul Wurman, **Information Anxiety**
New York: Doubleday, 1989
Wurman's book makes a strong case for making information understandable at all costs. Especially useful in talking with students about the design of information are the sections on the "five rings" of information (sources of information) and ways of organizing information.