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COMPUTER GENERATED ANIMATION IN THE CLASSROOM: TEACHERS' PERCEPTIONS OF INSTRUCTIONAL USES AND CURRICULAR IMPACT

The Ohio State University

Ph.D. 1986

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COMPUTER GENERATED ANIMATION IN THE CLASSROOM: TEACHERS' PERCEPTIONS OF INSTRUCTIONAL USES AND CURRICULAR IMPACT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of the Ohio State University

By

Patti R. Baker, B.A., M.A.

* * * * *

The Ohio State University
1986

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1986
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Educational Technology

Computers in Education

Educational Research
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The enthusiastic embrace of state of the art computer generated animation is evident by its widespread use in advertising, the movie industry, the art world, and as a topic in the popular press. These electronic images fascinate, captivate, and motivate the viewer. Computer generated animation will eventually become available to education as the price of the hardware required for the display of these images drops to the level of public school budgets and production costs come more in line with educational markets. The availability of a new technology for use in the classroom necessarily forces educational technologists to consider the usefulness and effect of that technology upon learners and learning.

The realignment of notions regarding what can be taught with which materials is not a domain exclusive to the educational technologist, however. The classroom teacher is an important link between development and implementation and is a source whose perceptions of the utility of computer animation is not only to be understood but to be sought. How this new technology is implemented into instruction and how curriculum may be affected is consequently dependent upon what questions are asked before, during, and after the design process and who will be asked the questions.
The purpose of this study is to take a proactive approach to the implementation of new technology into the classroom. By providing a forum for practicing teachers to view and react to the form and function of state of the art computer generated animated graphics, this study explores the instructional uses, curricular impact, and factors of utilization from the viewpoints of those who will be asked to eventually implement this technology.

Background

Instructional designers do have the difficult, but exciting, task of implementing the potential of powerful computer animated graphics in the learning environment (see Figure 1). There is a tendency, however, for designers to treat "hybrid technologies" as though they were simply enhancements of the old technologies (Willis, 1982:1). The consequence is that the implementation of a new technology such as computer generated graphics may follow the history of the implementation of many innovations in classrooms: nothing new is being implemented, the old content is simply being presented in a different package. DeBloois (1982:101), for instance, described the stages that every media innovation has gone through: birth, death, and resurrection. At birth, unrealistic projections are made from lack of understanding its capabilities and impact. The result is haphazard development. Disappointment in the innovation's performance leads to its death. At death, however, careful analysis begins in an effort to understand what went wrong. This careful evaluation eventually leads to the innovation's resurrection.
Figure 1. "Snoot and Muttly" by Susan VanBaerle and Douglas Kingsbury, Computer Graphics Research Group, The Ohio State University
The value of new media, according to Schwartz (1983:138), lies in
the ability to bring to the student material that cannot be seen or
heard in any other way. However, to wait for such technology to reach
the classrooms before testing its instructional effectiveness is to
deny the opportunity to have needed answers ready when the questions
are asked. There is also the problem of investment. The speculate-
design-then-test sequence increases the investment in the product, and
the greater the investment, the greater need for the innovation to
succeed. Closer examination may be avoided for fear that the
innovators were wrong in their design, thus a product is not as
carefully evaluated as it should be (Miles, 1964:656-659). An
additional factor in evaluation is that failure is rare from the
perspective of those directly involved in an educational experiment
(Shamos, 1982). Rationalization of the product consequently becomes
more important than the outcome of the innovation's dissemination.

The challenge lies in the ability to anticipate what curricular
change and instructional benefits may come from state of the art
technology that will be available in the future for education. Damarin
(1982) proffered three issues regarding emerging educational technology
that should be considered. In addition to the issue of the
implications for teacher education that new technology raises, two
other issues are considered most important for this study: 1) "How can
and should the proliferation of computers and the growth of computer
related technologies affect the content of curriculum," and 2) "How can
and should the availability of computers in schools affect the quality
of appropriate content?" When Floyd (1982:78) spoke of the
possibilities of videodisc, for instance, he forecast that both the structure and quality of education may change as a result of these successfully implemented technologies. Bork (1984a) predicted that the increased concern for improving education will lead to large scale development of new curriculum materials, and these courses will assume that the computer will be central to the learning environment.

Who will be responsible or involved in this curriculum change? Floyd (1982:75) challenged the propensity for adaptation of existing materials to new technology and suggested that strategies that are going to make the most of a technology must begin from the ground up. The "ground", many feel, consists of the teachers, those practicing professionals who interface the curriculum and the students. The purpose of educational design is, according to Nunan (1982:22), "to facilitate teaching and learning, and, in the last analysis, stands or falls at the level of classroom life." Teachers determine through practice what will be implemented or ignored. They are generally sensitive to the effects of instructional practice upon their students and are cautious of change whose long term effects are not known. As a result, teachers need to be convinced as to the usefulness of an innovation before they will accommodate change (Sandeen, 1983).

Although instructional systems are designed to help learners learn, effective use of educational technology won't be fully realized until the design of systems are also based upon the idea of helping teachers teach (Office of Science and Technology Policy, 1984). Thus, the real power in school reform lies in the power of teacher consent (Common, 1983).
Much of reform failure has stemmed, for instance, from the common practice of designing curriculum by people other than teachers. This tradition has placed teachers in the role of user, or consumer, rather than creator of curricula (Common, 1983; Nunan, 1982). Nunan (1982:12) in his book Countering Educational Design decried the loss of local control over instructional design. Instructional design, like innovation, used to be based upon experience. It was "personal, local, adaptive and wedded to the teacher's role." Now design is tied more to measurement. It is approached scientifically and handed down to the teachers to be implemented (Nunan, 1982:2). Design, then, needs to derive meanings, expressions, and purpose from the teaching/learning experience or else the teacher is simply a presenter or implementer of another's expression or goals (Nunan, 1982:82). Floyd (1982:128), again in addressing the design of videodisc materials, called for the consultation of experts, the "practising" experts who can bring their expertise to the design process. These experts, Floyd continued, are the "teachers who can truly teach, whose students continue to excel whatever system they are in..."

There are several solutions to the dilemma of control and effectiveness of curricular change that could result from the availability of computer animated graphics in instructional design. Appropriate decision-making needs to be preceded by appropriate question-asking and, of course, there needs to be resources from which answers come. The power to reform schools, (hence the power to incorporate effective instructional design), must be shared (Common, 1983). Bear (1984) pointed out that microcomputers, for instance, did
not evolve from the recommendations of practice or practicing teachers. A team approach, utilizing the expertise of the instructional designer, and the expertise of the practicing teacher, seems to point the way to substantive design and meaningful reform. As succinctly said by Havelock (1973:17), "A large part of change is exchange."

Exchange is central to this study: exchange of expertise between practicing teachers and the investigator who is an instructional designer; exchange of notions within teachers as they confront the power of state of the art computer graphics. Nunan (1982:118) suggested that a sensitizing to the "images, values, and structures of environments is a fundamental precursor to change." By establishing a forum for teachers to experience and react to computer generated animation graphics, this investigator hoped to elicit not only instructional needs that haven't been met by current instructional technology but also identify new curricular content that could now be possible because of state of the art computer graphics. Recommendations for both curriculum development and computer graphics production result.

An examination of teachers' constructs regarding instruction, media, and curriculum is also intended to illuminate teachers' perception of the utility, effect, and probability of acceptance of these electronic images for instructional purposes. In a study on teacher constructs and curriculum change (Olson, 1980), the research was based upon the assumption that how the teacher construes his or her role in the classroom determines how that teacher will deal with a change proposal. As stated by Common (1983) when she cited the failure
of school reform, "We must start by trying to understand the people who want to determine what goes on in our classrooms."

**State of the Art Computer Generated Animated Graphics**

Three dimensional computer generated animated graphics (hereafter referred to as computer animated graphics or computer animation) have been the topic of both popular and academic articles. The potentials and power of computer graphics have been linked to commercial enterprises (Harris, 1984), traditional arts (Baker & Zavotka, 1983), art and aesthetics (Motil, 1983), educational research (Baker & Zavotka, 1984; Cambre, Taylor, Belland, 1984), the military (Deken, 1983:158-159) and entertainment (West, 1984). The intensity of involvement by artists, the television industry, the military, and industrial designers is exponentially growing as possibilities for this technology are realized.

The recent development of three dimensional computer animation has opened the door to sophisticated design techniques, flight simulation applications, and special effects for the entertainment industry (see Figure 2). After an initial controversy as to the legitimacy of computer "art", many artists embraced the new technology as a serious medium. Monetary and aesthetic pay-offs ultimately became responsible for the intense interest in computer graphics technology.

The attributes that make computer graphics so amenable for artists also enhance use for the marketing industry, and, eventually, for education. As a tool, computer technology allows artists to work in an environment of experimentation that was previously too expensive and
Figure 2. "Bouncing Balls" by Robert Connelly, Computer Graphics Research Group, The Ohio State University
tedious to attempt. An infinite number of images or designs can be generated and assessed with less time and effort than with conventional graphics methods. For advertising or designing, the flexibility of computer graphics generation reduces costs, and allows for maximum aesthetics and design control. As expressed by Deken (1983:106), "Computer imagery enables the designer to have the best of both worlds: the realism of a physical scale model as well as the insights provided by seeing tangible forms of what were until now strictly imaginary views."

As an instructional tool, computer graphics are an unexplored medium. But the promise of computer graphics in instruction seems to lie in the ability of the artist to model, via the computer, dynamic phenomena (T. A. Linehan, personal communication, August 22, 1985). Multiple viewpoints and movement allow the viewer to watch the interaction and inter-relationships of systems such as the circulatory system. Interactive computer graphics would allow an even higher level of comprehension and participation.

The Functions of Instructional Design and Educational Technology

Both computer graphics as an artistic medium and computer graphics as an instructional medium need to be clarified at this point. Belland (1976) described media as "...communications processes which enable the storage and/or distribution of human experience," human experience being the extension of human functions and capabilities. Salomon (1970) offered a definition for instructional media: "...a package of unique modes of presenting information which also fulfills a unique
psychological function." A triangle is thus formed by the learner's perceptual and cognitive make-up, task-specific processes, and the medium. Belland's and Salomon's definitions lead well into a definition of instruction itself: the arrangement of human, temporal, material, and spatial resources to facilitate learning (Belland, 1976; Hough, 1980).

The instructional designer, of course, is set with the task of arranging material resources while keeping in mind the human, temporal and spatial resources. Essentially, instructional design attempts to create compatibility between the learner's attributes and what is to be learned as well as determine how that learning will be structured. Gagne (1977) identified these elements as the external and internal conditions of learning as well as the events of learning. Models of instructional systems design (e.g. Belland, 1984) categorize the components of the design process so as to help designers systematically "prescribe the sequence of events and functions for the tasks that lead to effective instruction" (Andrews and Goodson, 1980). A model of instructional design is not procedural, however, but is instead systemic in that a change in one component requires a change in other components (Andrews and Goodson, 1980). Instructional designers are encouraged by an appropriate model to use continual assessment and replanning that Belland (1984) said is central to creative design.

Most instructional systems design models include analysis of the task, describing learner characteristics, and planning strategy (Andrews and Goodson, 1980). Ausburn and Ausburn (1978), for instance, proposed an approach to instructional design that integrates task
analysis, learner description, and planning. Their approach considers
the cognitive style of the learner, the cognitive requirements of the
learning task, and the necessary assistance for the learner whose
cognitive style does not match the cognitive tasks. This assistance is
termed "supplantation," which can be conciliatory or compensatory.
Conciliatory supplantation would remove the cognitive requirement that
is causing the difficulty; this approach capitalizes on the learning
mode that the learner prefers. Compensatory supplantation, much like
Salomon's notion of supplantation, compensates for the learner's task-
related deficiencies by providing the process that he or she can't
perform independently. The animated rotation of an object in three
dimensional space, for instance, would model for the student the effect
of rotation upon the image of the object (see Figure 3). Ausburn's
model has three steps: 1) analysis of the learning task to determine
its basic stimulus-transformation requirements, 2) determination for
whom its needs to be supplanted, and 3) determine how to provide the
desired supplantation. These steps could, in Gagne's terms, provide a
better match between the internal and external conditions of learning.

Instructional designers may have models to follow, but there are
situational factors that influence the overall impact of media, that
are, nonetheless, outside their control: innovative practices and the
design and development of equipment (Allen, 1970). Because education
is big business, schools are prime targets of development and diffusion
strategies. Representative Albert Gore, Jr. (D-Tennessee), author of
the National Educational Software Act of 1984 is quoted by Bonner
(1984) as saying, "...our schools are being swept up in a tidal wave of
Figure 3. Images from spatial skills instruction animation, Susan Zavotka, The Ohio State University
technology without any idea of how to make wise use of it." To illustrate the surge in computer implementation, Bonner pointed out that the number of personal computers used for instructional computing has increased from 31,000 in 1981 to 325,000 in 1983.

One of the attractions of the personal computers for both designer and user has been the computers' ability to generate graphics displays in color, yet this capacity has inherent design problems. Since pictures have continually been shown to gain attention and add appeal to a task (Brody, 1983; Travers & Alvarado, 1970; Levie & Lentz, 1982), their inclusion in CAI seems natural. However, computer graphics used in micro-computer CAI are extremely primitive compared to the high resolution state of the art computer animated graphics that are generated by mini-computers. Computer graphics used in instruction are currently two-dimensional, or primitive three-dimensional, low-resolution images generated by microcomputers within computer assisted instruction (CAI). Colors can vary, usually, from 6 to 16 within an image, but color can still be an uncertain attribute in design because the lesson may be displayed on a monochromatic monitor rather than on a color monitor as the designer intended (Baker, 1983). The low resolution and lack of a rich color palette are consequently limitations to the inclusion of microcomputer graphics in CAI. Still, "micrographics" (Bloom, 1984) are very pervasive in the classroom as both art and instructional tools. Pictures are inserted into many instructional materials, and as computer graphics production systems become more user-friendly, the frequent insertion of these graphics are a certainty. Computer generated images displayed by microcomputers are
popular and electronic images produced by sophisticated technology are very dramatic, but it is possible that the traditional "Law of the Hammer" may be in force: Given a hammer, everything needs hammering. As Lewin (1983) stated, "conciliatory art", within or without CAI, is very much of a child's life.

The other factor outside the instructional designer's control is the development of the equipment for which he/she is trying to design. High technology seems to follow a time-proven principle: hardware systems development always precedes the development of courseware (DeBloois, 1982:144). As a consequence, adoption and implementation of educational technologies often precede plans for utilization. The innovation may be used inappropriately or prematurely abandoned. DeBloois' birth, death, and resurrection cycle stems, it seems, from solutions looking for problems.

For instance, interactive videodisc, an appropriate delivery system for computer generated animated graphics, is another technology that could follow the history of other innovations. Many times the implementation of videodisc involves the transferring of linear videotape to videodisc. Floyd (1982:75) pointed out that the transfer of existing programs doesn't utilize the initiative or creativity of the instructional designer and fails to take advantage of the attributes of the technology. DeBloois (1982:33) reiterated this caution when he said that an interactive video system is not the merging of the video and computer media but the creation of an entirely new medium. Videodisc is one medium, however, that can currently utilize computer generated graphics. The videodisc can employ higher
resolution graphics because filmed sequences of sophisticated graphics can be recorded and replayed under computer control. Equipment and programming costs are much higher, though, than computer graphics resident in the software. If the laser videodisc can be refined and priced appropriately for the home market, the educational and industrial market will certainly benefit (Wood, 1982:136). The additional costs of the computer generated animation make such applications prohibitive for the time being. Educational technology has many tools at its disposal but the uses have not been clearly defined nor has the ability to pay for them been identified.

The question remains, however, as to what could be done with computer animation technology if it were available for instruction? An article in Technology Illustrated (Merton, 1983) quoted Robert Tinker of the Technical Education Research Centers as saying in regard to computers, "One is left with a sneaking suspicion that we have no idea yet how to use this technology; the technology has far outstripped our imagination".

Problem Perspective

Computer graphics technology may have also outstripped the imagination, although computer artists are approaching the challenge with vigor. Charles Csuri, executive vice-president of Cranston/Csuri Productions and director of the Computer Graphics Research Group at The Ohio State University said he couldn't sleep the night after he saw his first computer generated image some twenty years ago. "I knew I had to find out what could make that happen" (Motil, 1983). Csuri said that
computer art is more than just another new art form, "It will change our lives." However, Csuri was quoted a year after the interview with Motil as saying that he was disappointed with the computer art that's out there; it's too serious and boring (Harris, 1984). Linehan (1983) advised that "...picture-making by computer is here to stay. Art educators can help shape both the quality and direction that picture-making takes..."

For instructional designers, a consideration is how to utilize the power of an art form for instructional purposes. A pleasing image does motivate (Brody, 1983; Duchastel, 1978), but does it inform? How an illustration looks, i.e. pictorial attributes such as complexity and realism, has usually taken precedence over what the image is supposed to do, and Duchastel (1978) suggested that instructional designers begin to consider function before form. Can one be considered without the other? A definition of design by Robert Wagner (1984) that encompasses both function and form was given as "...the thoughtful, artful, organic application and creative control of a learning experience." The challenge in instructional design is to apply, not insert, pictures that are not only pleasing to view but are also mathemagenic in nature. Thus, the richness of artfully produced computer images can provide a cogent learning environment for students.

Given these electronic images, new questions need to be asked. Damarin (1982) asked in regard to increasing use of technology in the classroom, "Who will seize the initiative...and... what will be the response?" A review of the literature reveals that visualized instruction is more effective than verbal only instruction (Canelos,
1984; Levie & Lentz, 1982), but pictures also need verbalization to increase semantic learning (Korosik, 1983). Could it be that the kind of picture that can singularly communicate visually yet enhance verbal learning has never been produced because of lack of design or technology? Although the construct of dual-coding (Paivio, 1974) supports the inter-relatedness of image and word, the tremendous manipulation of images provided by computer technology increases the likelihood of discovering more powerful graphics and uses of those graphics that may equal or over-ride verbal processing. In conclusion, Bork (1984a) emphasized the massive curriculum development to emerge out of the production sytems that allow and encourage curricular change. What will be the content and philosophy of the emerging curriculum?

**Significance of the Study**

It is the potential effect of computer generated animated graphics on instruction and the curriculum and teachers' perceptions of those effects that are the foci of this study. Illustrations in texts, filmstrips, and film produced by conventional graphics have been the norm, but now instructional designers will have in hand types of images that have never been imagined to be used educationally. The ability of state of the art computer graphics to model dynamic phenomena in three dimensional space provides tremendous instructional applications.

The significance of the study is its potentional contribution to the design, dissemination, and research of computer generated animated graphics. The data should yield insight as to how computer graphics
can effect curriculum and instruction as well as provide questions for both experimental and naturalistic research. The study is thus a proactive approach toward the investigation of instructional media. By anticipating the use of a new technology, perhaps some common negative factors in innovation dissemination and curriculum reform can be avoided. An anticipatory approach also lays a foundation for meaningful research before an innovation has become fully implemented, and perhaps entrenched. Finally, the anticipation of a new instructional tool allows for investigation of the benefits of such a tool for learners; thus, when the technology is implemented, it is in a form that is effective for those that need it.

Although there are no precedents for the making and understanding of sophisticated computer graphics (Csuri as quoted by Motil, 1983), the utilization of graphics does not need to repeat, for instance, the history of the implementation of computers into the schools. Computers were handed to educators before the educators had an opportunity to ask why or how. The computer revolution in the schools has resulted in what Havelock (1971:3-30) called the "disorganized consumer."

The problem with getting answers from outsiders before the questions are formulated by the inside is that the right questions may never be asked. Because the technology for sophisticated computer graphics is not currently available for elementary and secondary education does not preclude future availability. State of the art computer graphics are currently produced on minicomputers such as the VAX 11/780, but hardware manufacturers are claiming that they will have
table top versions of these computers by the end of the decade (Linehan, 1983). Preparing for that someday means that instructional designers will have some serious applications for the technology. By anticipating the use of a technology before its availability is to give educators the opportunity to ask, before implementation, not only if images are effective but under what conditions and for what purpose. Over a decade ago, Travers and Alvarado (1970) offered hindsight that is appropriate for any new stage of technological advancement in instructional design, "It is unfortunate that the technology for producing pictures cheaply, either in print or on celluloid, developed before an analysis had been made of the functions that such materials can usefully perform in education."

Educators can take advantage of some other hindsight to avoid past failures in curriculum reform. After Sputnik in 1957, it was widely believed that the key to improved science education was massive curriculum reform. Efforts were a failure (Shamos, 1982). Reformers forgot that the curriculum was secondary to teacher effectiveness, student ability, time spent, and many other factors of learning. Jalongo (1982) stated that if innovations are to be successful, they need to allow for self-actualization in both the educators and those being educated. Thus to consult teachers, the practising experts, is to break with traditions of failure in curriculum reform and to join with willing partners in improving education.

Needs identified from outside education, such as improved science education after Sputnik or computer literacy "after Apple" are not necessarily invalid, however, but educators are expressing
dissatisfaction with the way computers, and consequently graphics (Allesendrini, 1984; Bork, 1984b), are being adopted and utilized. F. James Rutherford of the American Association for the Advancement of Science was quoted by Bonner (1984) as saying, "Our failures in the past have had less to do with overestimating the power of new technologies than with underestimating the effort necessary to exploit that power." This study will attempt to find ways to exploit the power of computer graphics for instructional purposes and curricular impact.

The lack of a research base is also a contributor to poorly planned and implemented innovations. Research findings should inhibit the oscillation of educational fads and establish a foundation for change that will result in better and longer-lasting change (Gage, 1978:43, 93). Thus, the artful implementation of electronic images in instructional materials need to follow upon the heels of scientific rationale. Campbell and Stanley (1963:21) propose that ideas for classroom research originate with teachers and other school personnel and be designed and carried out by researchers. Both rigor and relevance can be maintained in such collaborative studies.

Not to be forgotten are the students whose cognitive style does not fit popular modes of instruction. Cognitive style as defined by Ausburn and Ausburn (1978) consists of the "psychological dimensions that represent consistencies in an individual's manner of acquiring and processing information," and those who acquire and process information better in a visual manner are shortchanged today. The social and educational movement from imagery to dependence on verbal information has been especially hard on those learners who are strong visualizers.
The development of the printing press and mass-produced books meant that people didn't have to form images of words or information they wanted or needed to remember; this phenomenon influenced not only methods in teaching but beliefs about cognitive processes (Wittrock, 1978). Most people would acknowledge that we live in a visually oriented society as evidenced by the plethora of television, rock video, advertising, and the cinema, yet verbal thinking is emphasized in our schools (Hortin, 1982). The modern classroom centers upon words and numbers, and teachers do not value visual thinking (Sommer, 1978:54-55). Consequently, strong visualizers are often mis-diagnosed as learning disabled. They are learning disabled in the verbal world, but given the appropriate visual environment, these students could emerge as normal or, perhaps, gifted learners. It is possible that many learners are misdiagnosed as "slow" because they never have had the opportunity to learn in the way they learn best (Reinert, 1975). Differences in learners should not have to result in differences in learning (Ausburn & Ausburn, 1978).

The findings of the study should have both practical and theoretical significance for instructional designers, educational researchers, and computer graphics producers. Most importantly, the results may be used to benefit the efforts of those most intimately involved in the educational process: the teachers and students who are always in need of sensitively designed, and effective, instructional materials.
Definition of Terms

The following definitions are used in this study:

1. **Computer generated graphics**—high complexity computer-generated three-dimensional animated or still images. Other terms used to describe computer generated graphics in this study are: electronic images, computer graphics, and computer animated graphics. The images used for this study were computer generated **animated** graphics.

2. **Personal Construct Theory**—a theory developed by George Kelly (1955) that attempts to explain the manner in which people make sense of their experience. A construct system describes one's knowledge and views of the world.

3. **Utilization**—The manner in which instructional materials are integrated into classroom activities

4. **O-sort technique**—a method of eliciting responses, usually through card sorting, by the rank ordering of statements

5. **State of the art**—the level of development in technique reached at any particular time usually as a result of modern technology
6. **Purposeful sampling**—particular subjects are included because they are believed to facilitate the expansion of the developing theory (Bogden & Biklen, 1982:67).

**Summary**

State of the art computer generated graphics are a commercial reality and an educational possibility. By studying how practising teachers perceive the usefulness of these electronic images, instructional designers can begin to understand how those attributes of computer generated graphics can be applied to instruction as well as investigate the factors that will determine adoption and adaption of this new technology. This study provides an initial exploration into educational uses of computer generated animated graphics and the identification of research questions to be investigated before and during design and implementation.

The documentation of the study is organized in the following manner:

1. **Chapter I** identifies the educational use of computer animation as the problem area and describes the rationale and background for the research.
2. **Chapter II** is a review of literature related to the research.
3. **Chapter III** outlines the rationale for the design and methodology of the study.
4. **Chapter IV** presents and analyzes the data from the interviews with the teachers.
5. *Chapter V* describes the methodology, construction, and results of the Q sort that served as a triangulation of the interview data.

6. *Chapter VI* provides a summary of the study and describes implications for further research and implementation.
CHAPTER II

REVIEW OF RELATED LITERATURE

The instructional use of computer generated animation needs to consider the form and functions of pictures, the learner's ability to extract relevant visual information, the relationship between animation and learning, and the unique attributes of computer generated animation. Also to be determined are meaningful research questions for this powerful technology and as well as the appropriate paradigm for investigating the phenomena of instructional media.

Research on Media or with Media?

There has been much debate over the correct approach to media research. Media comparison studies grew out of the hope that the correct mix of medium, student aptitude, content, and learning task would facilitate learning (Clark, 1983). Media selection models and schemes resulted. Clark, however, found that a review of meta-analyses of media comparison studies consistently showed that media do not influence learning under any conditions. What does influence learning is the content, not the vehicle. As Clark said, "The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition." Clark
concluded that significant results that did occur for particular media effectiveness probably came from differences in content or instructional methods or from a novelty effect that seems to accompany newer media. Bear (1984) suggested a similar correlation when he surmised that research will show CAI to be effective in classrooms that are characterized by elements of instruction that are normally associated with effective teachers. Media comparison studies are still tempting for some researchers, however, because of the investment into new technologies and the high expectations held for those technologies being implemented (Clark, 1983). Clark also presented some evidence that journal editors tend to select research that shows stronger effects for newer media.

An interesting debate over Clark's conclusions has been documented in *Educational Communications and Technology Journal*. Petkovich and Tennyson (1984) challenge some of Clark's points on three grounds. First of all, Clark's conclusions are based on classroom studies, and therefore many unexplained and hidden variables are present. Secondly, Clark does not take into consideration the relationship between human information processing and how media attributes can operate as enablers of information processing. Third, the authors cite recent research on computer-assisted instruction that does not support Clark's claim that "media do not result in learning benefits under any condition."

Clark replies in an addendum to Petkovich and Tennyson's article (Clark, 1984). In his response, Clark distinguishes between the contribution of media to learning and achievement and the contribution
of media to more efficient delivery of instructional programs. Clark claims that many professionals in the field confuse those two roles of media and are consequently misdirected in their research. He also defends his meta-analysis of studies by saying that laboratory experimental studies as well as classroom studies were included in the meta-analysis of data, and that the lack of evidence for media effects was even more obvious in the laboratory studies. Rather than researching media attributes have consistently have shown no promise as viable factors in learning, Clark says that instructional technologists should investigate the three classes that seem to most influence learning from instruction: instructional method, learning task characteristics, and student aptitudes.

Petkovich and Tennyson (1985), however, insisted on the last word. In their rebuttal, they restate evidence that "media can influence learning if one understands the necessary conditions for learning, and that a particular medium (the computer) allow us to boost student achievement in a way that is impossible without it."

Clark (1983) and others (Salomon & Clark, 1974; Duchastel, 1983) are suggesting a new direction for media research in which the questions how and why illustrations and media are effective are asked rather than just if there is any effectiveness. According to Salomon (1970), a move toward a theory of instructional media would necessitate research that must: 1) generate a framework of valid questions to be asked, 2) be closely related to research in other areas such as human development and cognitive processing, and 3) deal with the functions of media. Additionally, Saloman gave the caution that
researchers need to distinguish between research on media rather than research with media. Research with media uses media as a stimulus source, but doesn't offer explanations for the functions of media. Canelos (1984), for example, offers some valid questions for research on visualization to improve learning; but Canelos' suggestions for research mostly asks the type of questions that are independent of the medium, i.e. What are the effects on memory of visual advance organizers when learning academic content? and What is the relative effectiveness of realistic or abstract visuals in micro-computer instructional programs and degrees of realism? Research on media will examine, however, the relationship between how things are presented and how they are learned. As an example, Canelos (1984) asked the question: What are the effects on memory of interacting and moving instructional visuals, or visuals constructed by the micro in real time? In other words, the question being asked is directly related to a unique mode of the presentation of information which fulfills a unique psychological function.

Salomon (1970) proffered five questions to be raised in media research:

1. What are the physical elements (attributes) unique to a medium that may influence learning?
2. What is effected by these identified attributes?
3. How do these attributes influence learning?
4. Under what conditions do these attributes influence learning?
5. Who is to profit or be hampered from the impact of these attributes?
The type of generalization that would emerge from these five questions are presented by Salomon (1970) in the following sample:

"The medium [film........computer] is capable of presenting [........] unique kinds of messages, which in turn can fulfill the psychological functions of [arousal....supplantation....reinforcement] of the mental processes of [comparing....relating....identifying] which in turn are needed by learning tasks of [........] sort for a learner of [........] mental or emotional characteristics."

Clark (1983), however, said that media attribute theories would benefit instructional design but be of limited benefit in explaining necessary conditions that are to be met by effective methods. He suggested instead a recent approach to research that examines learner attributes and beliefs about the instructional and entertainment qualities of different media. Clark (1982), for instance, found that aptitude treatment interaction studies show a "negative correlation between achievement and enjoyment in instructional settings." It seems that students misjudge the type of method that is appropriate for them, and they enjoy the instructional method from which they learn the least. High ability students learn best from more permissive methods because they do more processing, but they prefer more structured methods because they perceive the tasks to more efficient. On the other hand, low ability students like more permissive methods because they are able to maintain a low profile, but they learn more from structured methods that reduce the processing load.

Previously, research was based on the classes of media such as film, television, and CAI, for instance, to the exclusion of factors that are more directly related to learning (Allen, 1970). A classification of research on instructional media undertaken by Allen
was prefaced by the citing of evaluative research as "... unproductive in terms of direct, scientific contributions or generalization to a consideration of those individual and situational factors that may interact with media to make them more or less effective instructional instruments." The classification system, which follows, addresses the factors that interact with media.

"I. Factors relating to the stimulus such as characteristics of media types
   A. Stimulus presentation forms
   B. Media production variables
   C. Internal organization of media

II. Factors relating to student responses

III. Factors related to content attributes
   A. Subject matter content
   B. Broad instructional objectives
   C. Learning hierarchies
   D. Learning tasks
   E. Instructional functions or technical skills
   F. Content inherency

IV. Factors relating to learner attributes

V. Factors relating to psycho-physical processes

VI. Factors relating to instructional use.
   A. Teaching techniques
   B. Instructional strategies
   C. Teacher characteristics

VII. Factors external to the direct instructional situation"

Allen acknowledged that media research cannot be so neatly packaged into categories and that it is necessary to investigate the interaction of several of these variables. Salomon (1970) furthermore described, in addition to the implications for research, the knowledge a researcher needs to know in order to conduct meaningful research: the nature of the processes to be learned, the degree of previous
knowledge the learner has regarding the targeted task, and the general level of mental activity of the learner relative to the learning task. He jokingly suggested a title for a book that would give such prescriptions, The Impossible Research Procedures. Humor aside, there is a very important question to be answered. What sort of methodology would be appropriate for media research?

Controversies in Methodology

Where controversies abound in what should be researched, controversies are equally numerous in how the research should be implemented. Qualitative versus quantitative research and everything in between is greatly debated as to appropriateness and validity.

The real issues of methodologies are really issues of strategy (Rist, 1977). As Guba (1981) pointed out, naturalism (the assumption behind qualitative research) and rationalism (the assumption behind quantitative research) are paradigms for inquiry, not a method. There are many paradigms for seeking truth, Guba explained, such as the legal paradigm or the paradigm used to judge athletic performance. One cannot be deemed better than the other, but what is to be considered are the assumptions upon which each paradigm rests.

Rist (1977) also spoke of paradigms. Resulting qualitative and quantitative methods reveal their own unique elements of reality, and to stress one reality over another is to affect both observations and reality. Quantitative research assumes human behavior to be lawful. Therefore, quantitative research seeks to simplify complexity by breaking reality into manageable components so one can predict,
manipulate, and control. Qualitative research stresses, however, the notion that reality cannot be broken into components without undermining the holistic nature of reality. Furthermore, Rist compared quantitative research as being especially concerned with reliability, the ability to replicate the study. Qualitative studies are more concerned with validity, that what they are recording is a valid representation of what they are observing.

It is the tension between external and internal validity, however, that Salomon and Clark (1974) addressed. Generalizability offered by external validity can be built into the research design but at the cost of control of variables (internal validity) and vice versa. Salomon and Clark asked how one can conduct research on the real world and yet maintain internal validity, and their answer was to begin in a naturalistic setting and work backwards to a more tightly controlled test. They offered two designs appropriate for field studies: 1) a pseudo experimental design in which independent variables such as relevant individual differences and amount of student exposure to program are measured in the naturalistic setting, and 2) a staged innovative design where some schools are randomly assigned and introduced to an innovation sooner than others. This design employs the early and late subjects as temporary control groups. Experimental studies can utilize: 1) an ecological design which has at its center ecological validity, the extent to which situations compared in an experiment are representative of the population of situations to which the researcher wants to generalize, and 2) the rotation design, a simpler version of the ecological design. The purpose of these designs
is to move research away from the internal or external conflict of validity.

Is it possible to mix the two paradigms? According to Gage (1978:83), it is unlikely that either the quantitative researcher or the qualitative researcher "will accept the other as a replacement." Gage continued, though, by expressing the hope that both paradigms could mutually exploit each other so that each will benefit from what the other reports. Quantitative researchers need to understand that what is observed by ethnographers proves that the phenomenon is possible. Ethnographers, on the other hand, should realize that their data are insufficient to prove probability of the observed phenomenon. One solution described by Gage (1978:87) and utilized by Skinner is the intensive experimental design. Repeated observations are made of a single case before, during, and after some intervention. Contact with reality that is favored by the qualitative researcher is gained, and yet rigor and objectivity that is valued by the quantitative researcher is maintained.

Examining the contexts in which the naturalistic and rationalistic paradigms operate do offer some hope as to how a mixture of methodologies can be attempted. While "...the qualitative researcher can discover new phenomena and relationships or create new hypotheses..." the quantitative researcher can "...test, validate, or justify the hypotheses" (Gage, 1978:83). The context of discovery and the context of justification fit well together as partners in the process of inquiry.
The Use of Visuals in Instruction

Controversies similarly abound in research on visuals in instruction. The use of visuals in instruction such as drawings, photographs, film, CAI, and television is widespread and generally accepted as a complement to regular classroom instruction (Dwyer, 1978). A plethora of published research and theory regarding visualized materials is one result. A categorization of visuals into either types, functions, or purpose has been one approach. Another tactic has been to study the cognitive effects visuals have. The use of animation in instruction forces consideration of other modes of visuals besides static. In the last analysis, one needs to ask, "What are pictures, and how do learners extract information from them?"

Merrill and Bunderson (1981) categorized visual displays as alphanumerics, graphics, and objects. The graphics category includes nonalphanumeric, two-dimensional displays which are divided into four subcategories: figural, symbolic, schematic, and pictorial. This taxonomy described pictorial and schematic categories, also to be considered iconic, to include "...all two-dimensional representations of objects or events where the representation has some degree of resemblance or fidelity to the physical characteristics of the real object." The higher degree of fidelity distinguishes the pictorial from the schematic. A pictorial graphic may be a photograph or a drawing, and a schematic may be a rendering of an electric circuit. A symbolic graphic bears no resemblance to a real object but serves as an arbitrary sign. An example would be a trademark. Figural graphics are used to show relationships between abstract ideas and include such
graphics as line graphs and flow charts. Merrill and Bunderson also give other ways of categorizing pictures that can be thought of as subordinate subcategories: still or motion; color, halftone, or black and white; degree of aesthetic value; degree of complexity or realism; and/or analogical reference.

While Merrill and Bunderson classified visual displays by physical attributes and function, Knowlton (1966) categorized visual-iconic signs by meaning. When the taxonomy of visual-iconic signs are independent of physical attributes, the sign needs to be analyzed in a manner that accounts for the verbal context in which it is embedded. However, in the attempt to develop a "meta-language" for talking about pictures, he preferred to define pictures and other visual-iconic displays as signs.

Iconic signs are those that resemble that for which it stands, thus, Knowlton included in this definition drawings, paintings, photographs, and statues. This scheme is contrary to that of Merrill and Bunderson (1981) who placed pictures and statues into different categories. They preferred to avoid the iconic-digital dilemma. Knowlton (1966), for instance, described digital displays as having no resemblance to its referent (such as Merrill and Bunderson's symbolic category) and are arbitrary. According to Knowlton, pictures are not totally nonarbitrary, so a visual representation is considered iconic if at least one of its three essential parts is nonarbitrary. The three parts of a visual-iconic representation are: the elements, their pattern of arrangement, and their order of connection.
Testing of this scheme yielded for Knowlton three superordinate categories of iconic displays: realistic, analogical, and logical. Although the realistic category includes pictures, Knowlton cautioned that it does not include all pictures. Realistic visual- iconic representations of some object in the visual world are realistic pictures if "...the communicator's intent is to make reference to the type of object portrayed." Analogical pictures make reference to something else and imply similarity. They illustrate concepts or topics by analogy. Logical pictures are very much like Merrill and Bunderson's (1981) figural graphics in that non-critical attributes are removed and a highly schematized representation results. The aforementioned electric circuit would qualify as would a road map.

Functions of pictures (the generic term "pictures" will be used for visual- iconic representations) have been a common categorization. Dwyer (1978:12) gave a list of twenty-two possible uses of pictures in instruction, but others were found to be more succinct. Brody (1983) listed six functions of pictures: 1) provide a change of pace, 2) gain attention, 3) make abstract information more concrete, 4) model cognitive processes, 5) make words more memorable, i.e. mnemonics, and 6) provide advance organizers. Duchastel (1978) put the uses of pictures in text into three categories: 1) attentional, 2) explicative, and 3) retentional. Under attentional, Duchastel attributed motivation, a familiar use of pictures. Also, the explicative serves a didactic purpose in teaching by showing. Knowlton's (1966) logical pictures would fit this category well. The retentional function of pictures is probably the most widely
researched. It is derived from theory and supported by instructional research. The center of all this attention is the apparent relationship between the iconic memory and resistance to forgetting (Paivio, 1970 as quoted by Duchastel, 1978; Fleming and Levie, 1978:108; Canelos, 1984). According to Travers and Alvarado (1970) the first systematic analysis of the functions of pictures was attempted by Smith (1960) who proffered incentive-motivational functions, information-giving functions, or both. Travers and Alvarado added a third function to Smith's list that proves intriguing: marketability.

The authors suspected, and lamented, that much pictorial material used for children's learning is designed for adult tastes because adults make the purchasing decisions. Levie and Lentz (1982) also produced a table of possible functions of text illustrations: 1) Attentional: attracting attention to the material and directing attention within the material, 2) Affective: enhancing enjoyment and affecting emotions and attitudes, 3) Cognitive: facilitating learning text content via improving comprehension and improving retention; providing additional pictorial information, and 4) Compensatory: accommodating poor readers.

The effects of illustrations in text have been intensely studied, and a review of the literature by Levie and Lentz (1982) yielded nine generalizations for practitioners or researchers.

1. "In normal instructional situations, the addition of pictorial embellishments will not enhance learning information in the text."

2. "When illustrations provide text-redundant information, learning information in the text that is also shown in pictures will be facilitated."
In other words, relevant illustrations enhance learning of illustrated text information.

3. "The presence of text redundant illustrations will neither help nor hinder the learning of information in the text that is not illustrated."

4. "Illustrations can help learners understand what they read, help learners remember what they read, and perform a variety of other instructional functions."

5. "Illustrations can sometimes be used as effective/efficient substitutes for words or as providers of extra-linguistic information."

The authors included this generalization as a reminder that words are sometimes over-rated, and visual thinking should be given some credence. Knowlton (1966) reported the use of imagery by outstanding scientists and mathematicians. Einstein, for instance, recalled that he often used visual and kinesthetic images when probing difficult problems. In the secondary stage of his problem solving, he would recast the new insights into mathematical notation or words. Knowlton classified Einstein's images as analogical and logical and suspected that those types of pictures have great importance for education.

6. "Learners may fail to make effective use of complex illustrations unless they are prompted to do so."

Diagrams consequently may not be processed if there are no cues to attend to it. In a study of self-pacing in micro-computer based instruction (Belland et al., 1985), a spatial free recall test showed dramatic drops in level of achievement across all groups. The subjects
attended well to verbal information but did not attend to pictorial information.

7. "Illustrations usually enhance learner enjoyment, and they can be used to evoke affective reactions."

This principle has been used by advertisers for years. Knowlton (1966) referred to the emotive property of pictures, such as paintings, in that they are nonreferential. They attract interest as aesthetic objects and function differently than pictures that direct attention for learning purposes.

8. "Illustrations may be somewhat more helpful to poor readers than good readers."

This generalization reinforces the notion that good students are more verbally oriented, and poorer students rely more on visuals. Learning to read is not to be confused with reading to learn, however. There is evidence that utilizing pictures when teaching vocabulary is detrimental to lower ability students (Willows, Borwick, and Hayvren, 1981 as cited by Levie and Lentz, 1982).

9. "Learner-generated imaginal adjuncts are generally less helpful than provided illustrations."

Learner generated images are less reliable and less robust than relevant illustrations provided the learner. The learner usually omits important attributes. Studies outlined by Levie and Lentz showed mixed results for the effects of using mental imagery to increase comprehension. Paivio (1980) encourages the use of mental imagery as an audiovisual aid for the student.
The use of an instructional visual culminates after a multi-dimensional process that systematically considers the learner, the learning objective, and the medium. The description of learner characteristics, a component of almost all Instructional Systems Design models (Andrews and Goodson, 1980), involves analysis of many human dimensions: intellectual, emotional, cultural, psychological, experiential, and physical (Belland, 1984). The learner, for instance, can sense information from several modalities: touch, sight, smell, sound, and taste. We learn, however, as little as 11% through hearing and as much as 83% through sight (Dwyer, 1978:11). This complexity of human perception prompted Paivio (1980) to compare human cognition to an elaborate audiovisual system. The system consists of two interconnected but functionally independent systems; the imagery system that interprets scenes and generates objects and the verbal system that involves the processing of language and the generating of speech. Once learner characteristics are determined, another major component of instructional design is the formulation of instructional strategies and the selection of media to implement those strategies.

Pictures have continually been shown to gain attention and add appeal to a task (Brody, 1983; Travers and Alvarado, 1970; Levie and Lentz, 1982) and thus their use is prolific. Additionally, pictures have been shown to almost always be learned better than words. Seeing images, for instance, decrease the time required for learning (Lipson, 1983). Gibson (1979:261-2) further explained the strength of visual information versus verbal information through the phenomenon of
information pick-up; information that has been put into words cannot be scrutinized as can visual stimuli. Although perception mediated with pictures has lost some function over experience in real space, pictures provide information closer to natural perceiving than verbal description. The positive effect of pictures on children’s learning is so well substantiated that research regarding that issue is no longer required (Pressley, 1977). In fact, visual learning is so strong, that when there is a conflict between vision and some of the other senses, vision wins out (Cassidy and Knowlton, 1983) as in the visual cliff experiments conducted by Gibson (Gibson & Walk, 1960). In these experiments, the mother stands opposite a glass-over visual cliff and calls to her infant who must crawl over the cliff. Even though the child can feel the glass, the infant steadfastly believes its visual perception system that communicates the presence of a drop-off.

To be considered in instruction, however, is whether or not the learner is able to extract the information that is intended to be communicated. Pictures can be different kinds of stimuli at different times and serve very different purposes (Cassidy and Knowlton, 1983). What is it that the child perceives when examining a picture or the environment?

For the purposes of this study, visual perception will be defined from a Gibsonian (Gibson, 1979) perspective. As described by another Gibson (Gibson, 1969:1-2), Gibsonian notions of perception differ from traditional associative theory of perception in several ways. Associationist theories of perception, one in which visual sensations gained meaning through association with actions which consequently
provided feedback stimulation, were challenged by major theories that emerged from research. Communication theory, which fathered information theory, pointed out the importance of speech and the structure of communication. The information theory which followed in the 1950's and 1960's drew attention to the consideration of alternative stimuli and response as well as discrimination, recognition and so forth. Neurophysiology next focused attention on the discovery that a stimulus is not confined to a point on a receptor surface nor to an instant in time; a stimulus requires change and is therefore relational. Thus, Gibson rejected the notions of the retinal image as a still picture, that perceptions of the world are caused by stimuli from the world, and that perceived meanings and values of things are supplied from past experience of the observer (Gibson, 1979:238).

Gibson's approach to perception is based on the pick-up of information. Information, according to Gibson (1979:242) is the "specification of the observer's environment, not specification of the observer's receptors of sense organs." Information, then, is not knowledge communicated to a receiver. The assumptions that information can be transmitted and stored are appropriate for the study of communication but not for perception, said Gibson. Information is simply there to be picked up.

Perception is an active process. One looks and listens, not just sees and hears. It is a continuous, unbroken activity that is adaptive, self-regulated and progresses toward the reduction of uncertainty (Gibson, 1969). Discovery of distinctive features and structure in the environment is central to the goal of extracting and
reducing information in stimulation (Gibson, 1969:4). Consequently, perception is functionally defined as "the process by which we obtain firsthand information about the world around us" (Gibson, 1969:3).

Gibson (1969:3) further explained that perceptual learning refers to "an increase in the ability to extract information from the environment, as a result of experience and practice with stimulations coming from it." This phenomenon, the increase in ability to extract information, is the next concern.

Development and Visual Perception

That there are developmental differences in visual perceptual abilities has no argument. Children interpret pictures differently than adults, and as a consequence they obtain less information (Campbell, 1981). How this change occurs is equally substantiated; experience and maturation are important factors in visual perception (Cassidy and Knowlton, 1983; Gardner, 1975; Gesell, 1949; Gibson, 1979; Gibson, 1969; Ginsberg & Opper, 1969). Gardner (1975) stated that children gain direct knowledge of the world through perceiving, making, and feeling. This experience provides practice in detection, discrimination, recognition and identification (Gibson, 1969:191) and, according to Piaget, emerges from social environment, experience with objects, and internal cognitive reorganization (Ginsberg & Opper, 1969:206).

Maturation appears to be experience's partner in visual perception. As described by Ginsberg and Opper (1969:206), cognitive development occurs not only with experience but with neurological
development. How maturation and experience interact, however, is not a settled issue. Piaget felt that true learning only occurs when the child has the necessary prerequisite cognitive structure to make use of the new experiences (Ginsberg & Opper, 1969:175). Gibson (1969:448-449) disagreed with Piaget's notion that young children are stimulus bound and that cognitive development "liberates the child from that bond." Basic components of vision are present at birth and develop in successive phases of increasingly greater specificity and complexity (Gesell et al. as cited by Gibson, 1969:27). Furthermore, perception is not matching a mental representation as Piaget would say but is, instead, extracting information. "We do not perceive less and conceive more as we grow older." Gibson explained by saying, "...as perception develops the organism comes to detect properties of stimulation not previously detected even though they may have been present. With growth and continued exposure to the world of stimulation, perception becomes better differentiated and more precise" (Gibson, 1969:77).

Visual information, as defined by Winn (1980), is information obtained by looking at a picture. Perceptual development consequently determines what information will be extracted. Gibson (1969:450-471) cited three trends in perceptual development: increasing specificity of discrimination, optimization of attention, and increasing economy of information pick-up and the search for invariance. Strategies of search, for instance, progress toward selective, systematic and flexible patterns. This phenomenon is supported by research as cited by Gardner (1975) which shows that children have more diffuse and less well organized scanning patterns. Their numerous small eye movements,
as opposed to adults' broader scanning patterns, affect their ability to examine a picture holistically. When encountering an informative area, children tend to lock onto it and don't scan other portions of the picture. Gibson further pointed out the inability of young children to ignore irrelevant information. Complex illustrations, for young children, could provide much irrelevant information. Line drawings, as an example, help point out criterial attributes (Holliday, 1980) that would otherwise be unnoticed in a complex representation.

What about the interpretation of pictures? Do children need to be taught this skill? Cassidy and Knowlton (1983) said no. There is little in developmental or even cross-cultural literature to say that people need to be taught how to interpret pictures. Decrying the term "visual literacy," Cassidy and Knowlton went on to say that "the ability to interpret pictures is more analogous to learning to speak than it is to learning to read." Some critical visual skills need to be acquired, he continued, but these skills depend upon given human capacities. A child's perceptual skills will develop without teaching. Gardner (1975) seemed to concur when he stated that most children have mastered the basic elements of a symbol system by the age of seven or eight. Therefore, they don't need training to read pictures but need training in what would be discriminated in pictures. Other evidence indicates that the ability to read relationships in pictures is experientially based but there is no additional increase after the onset of schooling (Pressley, 1977). The reason given by Pressley is that little experience is necessary to learn the rules relevant to interpreting information that is pictorially presented.
"Children cannot operate without knowing the rules of the picture-reading game, but the game is easy to learn. It just take a little practice" (Pressley, 1977).

The Role of Imagery

Paivio (1980) described mental images as conscious representations of our knowledge. He likened them to audiovisual aids in that they can be "intentionally and systematically used as an informational base for cognitive operations and as an aid to new learning." Another definition of an image came from Winn (1980): An image is "...a sensory (visual) experience in which there is some similarity between what is sensed by the "mind′s eye" and corresponding percepts, derived from the real world of experience, by the physical eye." Two categories of mental images were formulated by Piaget (1977:499). The first type of image is a reproductive image, that is, evoked sights that have been previously perceived. Second is the anticipatory image, envisaged movements or transformations (as well as their results) that have not been previously perceived. If one were curious as to the differences between imagining and perceiving, Gibson (1979:257) has the answers: 1) a surface becomes clearer when fixated; an image does not, 2) a surface can be scanned, an image cannot, and 3) imaginary scrutiny of an image does not yield new stimulation and extraction of new information.

Experiments as reported by Kosslyn (1975) support a constructivist notion of imagery and that the constructive process takes time. For instance, properties on subjectively smaller mental images took more to
time evaluate (that is, "see") than properties on larger images. Furthermore, more time is required if an object is imagined in a relatively complex environment. Kosslyn concluded that only a limited amount of processing capacity is available to representing visual images.

The paired associate paradigm is one of the most frequently used to study types of imagery. Two types of images, given by Pressley (1977), are: 1) imposed images, those provided by the experimenter in the form of pictures and 2) induced images, those that the subject is instructed to generate mentally. The evidence is overwhelmingly strong that recognition of imposed images is superior to verbal recognition at all developmental levels. Induced images, however, are not as evenly utilized across age groups. According to Piaget (1977:499), the mental images of the preoperative child are almost always static. There is, for instance, difficulty reproducing movements and transformations in the imagination unless they have already been perceived. Mental images don't have much reality for very young children. Three year olds in a nursery school refused to draw a picture in the air and asked for drawing materials so they could draw a "real picture" (Gibson, 1979:276). When children reach the level of concrete operations, however, they can reproduce movements and transformations as well as anticipate those in imagery. Piaget (1977:499) felt that such developmental patterns proved that the "...formation of mental images cannot precede understanding."

Research indicates that the ability to increase learning with induced imagery is very much a developmental phenomenon. By eight
The child can apply visual imagery strategy to complex tasks such as prose learning (Pressley, 1977). By sixth grade, children have relatively efficient mnemonic systems, but younger children in kindergarten and third grade don't (Mowbray & Luria, 1973). Given the research on induced imagery, Paivio (1980) posed a very important question for instructional designers, "Can AV programs be constructed so that they encourage learners to generate their own anticipatory images regarding the outcome of an event, rather than simply providing the images explicitly as part of the AV sequence?"

**Modeling Cognitive Functions**

That pictures gain attention is without argument. That pictures serve to model cognitive functions and have compensatory uses is currently a "hot topic" in educational research. Salomon (1979:83) hypothesized that the use of charts, graphs, and pictures could save mental effort, or compensate for the lack of a skill, and enhance the acquisition of knowledge. He warned, however, that skill development could be impeded (as described by Levie and Lentz, 1982). According to Salomon (1979:225-227), the symbol systems of media (a set of coding elements unique to a medium such as the zoom and slow motion is to film) affect learning in the following ways: 1) They differentiate aspects of content, 2) they vary with the ease of recoding, 3) some coding elements save the learner from difficult mental process by supplanting or short-circuiting mental elaborations, 4) symbol systems differ in the amount of processing they allow or require, and 5) symbol systems differ in the kinds of mental processes they call upon.
Salomon identified three skill-cultivating functions of symbolic elements of media: skill activation, skill short-circuiting, and skill modeling. Activation transforms external information to internal schemas, short circuiting gives the beginning and end result, and modeling executes the mental processes for the learner.

Three experiments were implemented to test these symbolic elements: the zoom, the laying out of solid objects, and the rotation of objects (Salomon, 1979:149-156). The results showed that initially high performers did better with activation and actually did worse with modeling, and initially low performers did better with modeling. Salomon concluded his book by saying that learning is mostly enhanced with activation rather than modeling or short-circuiting. Such learning, however, favors the skilled learner. The slow learner needs to have processes modeled, or supplanted, to compensate for lack of skills.

Animation

Modeling, or supplantation as Salomon called it, is appropriately portrayed by animation. Animation, as defined by Caldwell (1978), is the simulation of motion. This simulation of motion has some succinct educational advantages. First of all, the flexibility of animation production aids in the controlling of visual stimuli, and its motion draws attention better than other visuals. Practical uses of animation include: 1) portraying phenomena that can't be seen in real life, 2) can exagerate something that needs attention, 3) inject humor, 4) can depict a setting that is too expensive to model in real life, and 5)
can make a dull or embarrassing subject more palatable. Greenfield (1984:29) concurred with Caldwell that animation attracts attention, but she also added that the motion in film and animation helps children remember the action of a story and aids in the teaching of physical skills. The high attention to animation could be explained by its brevity, high action, low "visual noise," elements of fantasy, nonsensical events, and a high ratio of visual to verbal communication (Connel and Palmer, 1970 as cited by Cambre, Johnson, and Taylor, 1984).

The attention getting property of movement is part of the fascination with computer generated animation. Movement is both fun and easy to generate on the computer. Yet there may be a point where movement loses its mathemagenic properties and becomes detrimental to the learning process. Caldwell (1978) cited Vernon (1970:46-47) who found that children rely on vertical and horizontal cues for the identification of shapes. Thus, rotation of objects that don't maintain an upright appearance should be avoided. Furthermore, a study that compared an experimentally produced computer animation with a commercially produced cell animation (Cambre, Taylor, and Belland, 1983) revealed that the animation with the lesser amount of movement elicited more relevant words from the subjects. Although other factors may play in the differences, "movement" was mentioned twice as often for the animation with less movement. In another study, the fast pace of "Sesame Street" was liked better by children, but they learn more from the slower-paced "Mr. Roger's Neighborhood" (Singer and others,
1977). The conclusion for the observed difference was that the slower pace allowed for more information processing.

Cambre (1985), in a report on animation and learning, discusses the ability of animation to transcend geographical differences. Animation presented via the television has universal appeal and is an effective instructional tool world wide. Carefully designed animation can be adapted to different cultures and languages by changing the sound track. Instructional animations could then be efficiently and broadly disseminated.

Finally, another strength of animation may be the way in which it enhances the learning of spatial skills and concepts. Piaget (1971:73) described the instructional film designed by a Swiss educator who attempted to utilize the "maximum possible" dynamics and mobility of film to teach mathematics. The resulting decompositions and recompositions of the figures were outstanding, according to Piaget. Piaget (1971:74) was skeptical, however, of the role visually mediated learning could have in spatial tasks: "A pedagogy based on the image, even when enriched by the apparent dynamism of the film, remains inadequate for the training of operational constructivism." Perceptual spatial skills are dependent upon sensory impressions such as feeling and manipulating objects. Each time a student holds a cube and fills it with water he or she is gaining perceptual knowledge of that object. Furthermore, he decried the "intuitive methods" (those that employ imitation or demonstration) as a "process of providing students with speaking visual representations, either of objects or events themselves, or of the result of possible operations, but without
leading to any effective realization of those operations" (Piaget, 1971:72).

The research of Olson and Bialystok (1983) and Salomon (1979) presented evidence contrary to Piaget's theory. Salomon theorized that modeling a transformation would compensate for students who were lacking in spatial skills. As a spatial task, Salomon's notion of modeling was tested using an animation of a three dimensional object being unfolded to a two dimensional pattern. The low language learners learned the most from the visual modeling, and the proficient language learners learned the most from activation.

Like Salomon, Olson and Bialystok found that cognitive skills can be trained through particular forms of instruction. In the Olson and Bialystok experiment (Olson and Bialystok, 1983:164-181), subjects were shown either an animated film depicting the complete rotations of blocks, a partial rotations film, or a no rotations film. Another group was given direct block manipulation training, and another group served as control. Both the complete rotations animation group and the block manipulation group provided significant results. The authors concluded that twelve minutes of instruction equaled three years of untutored development in these specific tasks. Again like Salomon, the authors found that little was to be gained from showing a problem and then the solution if means of solution are not shown.

Animation, however, is not to be regarded as a panacea that will answer pedagogical questions about spatial visualization. As Salomon (1979:156) says, the results of his experiments do not suggest that a medium's symbol system is "...necessarily the best educational method
to cultivate a skill." He only claims that the symbol system of film can be utilized to affect cognition. Salomon (1979:110) further emphasizes the difference between the cognitive effects of a symbol system and its instructional effectiveness. The effects are the mental skills that are called upon to extract information during the task. The instructional effectiveness, though, refers to the correspondence between the mental skills activated and the skills required by the task. A poor match between the modes of presentation and the learner's internal information require additional "translations, conversions, or elaborations" on the part of the learner (Salmon, 1979:68). Learning can thus be facilitated by activating skills in the learner that are relevant to the task.

**Computer Generated Animation**

Three dimensional animation that is generated by larger computers has especially unique characteristics. Van Baerle (1985) describes some of these attributes. For instance, animated characters and their environments are described mathematically in three dimensions. "It is not an illusion of depth drawn frame by frame, but a synthetic three dimensional space described to the computers with numbers" (p.4). Van Baerle also points out that camera motion is not limited by real space. A character, object, or setting can be viewed from any perspective. As a consequence, computer generated animation has more front to back movement than hand drawn cell animation where side to side movement is dominant. In traditional animation techniques, any diagonal or front to back movement requires the redrawing of the perspective of each
frame. In computer animation that change in perspective is calculated by the computer. The ease of rendering multiple viewpoints of the character or object is a distinct advantage of computer generated animation.

The computer can also calculate images with numerous colored light sources. This task can be accomplished by traditional methods but not as easily nor as complexly. Because of this capability, the designer has available unlimited special effects and cuing techniques.

Finally, Van Baerle reiterates the ease with which changes can be made when design computer generated animation. Color, transparency, size, scale, position, orientation, and motion of any object or setting can be changed at will. She says, "Computer rendered character animation is not a new art form but an old art form under expansion because of developing technology" (p.2).

There is some concern over the effects of heavy exposure to the new visual communication media such as computerized picture. Metallinos (1985) wonders if constant and fast-paced movement along the z-axis (front to back movement) can disturb viewer comprehension. Furthermore, elements used to fill visual space are increasingly not reality-based. These "unreal cartoon-like images" could affect a viewer's understanding of the "dichotomy between the visual world and the visual field, and the unique properties assigned to each of them." In order to address these concerns, Metallinos suggests research on several constructs of z-axis staging: motion, depth of field, and direction.
The current form of computer graphics that Metallinos rejects and others applaud reflects its growth. Berton (1984) discusses some of the developmental phases of computer animation (or, digital cinema, as defined by Berton) has passed through. Like film, the earliest uses of computers to generate images were to demonstrate the technology and were not generally concerned with artistic merit (pp. 4-6). Process and function were more important than content and concept. Now the modeling of reality is the computer artist's mainstay. Charles Csuri (1985), in a talk to educators, stated that a major goal of computer artists today is to digitally represent the realistic movement of people and object through three dimensional space.

In addition to animating complex motion, another goal related to making realistic images is the attempt to overcome the inertia of logic of the machine (Roedel, 1985). In other words, randomness and disorder are part of our reality but not the computer's. In an interview with Roedel, Thomas Linehan of Ohio State's Computer Graphics Research Group, said that as these problems are solved, one targeted use of this technology is to illustrate abstract concepts from physics, biology, geography, and other areas in a manner we've never been able to visualize before. Comprehension of these abstract notions could be enhanced through the modeling of the processes.

Technique and theory are, however, most effective when they are invisible; they are then a background for the artist to be used as an unobtrusive tool (Berton, 1984:62). But if theory and technique are completely understood, then the artist has reached the limits of that medium. According to Berton, the limits of computer graphics are so
remote that technical development of computer animation and creative expression through computer technology seem unbounded. Berton states the potential of computer generated graphics in his summary: "One of the most invigorating aspects of...digital cinema is that the range of theory and technique is so great that the possibility of ever reaching the technical or theoretical limits is small indeed" (p.62).

Summary

The literature can be summarized into several main points:

1. Research with media is using media for delivery of the treatment and is much different from research on media. Research on media is attempting to identify unique modes of presentation of information which fulfill a unique psychological function. Not only are the attributes of a medium to be considered but the aptitudes and attitudes that the student brings to the mediated experience. Acknowledgement of the interaction of multiple variables is necessary for meaningful research that will help build theory rather than procedure.

2. Although there is a great deal of controversy over appropriate research methodology that will yield meaningful results, the question is really a matter of which view of the world one will use to explain phenomena. The qualitative paradigm holds assumptions of reality different from that of the quantitative paradigm. The qualitative paradigm is ecological in nature so phenomena must be examined contextually and holistically. Quantitative research, however,
attempts to explain human behavior by breaking reality into discrete components that the researcher can predict, manipulate, and control.

To use one paradigm at the expense of the other is to narrow the view and explanation of the world, and researchers are more frequently combining both methodologies in order more fully understand the question they are investigating. A complementarity of methodologies is looked at with more interest as a way of increasing rigor and validity of a study.

3. Visuals are ubiquitous in instructional materials but are not always carefully or effectively implemented. To be considered when employing visuals are the perceptual development of the student, the form of the picture, the intent of the picture, and the medium through which the picture is delivered. An undeveloped source of useful visuals is the student. Imagery has shown mixed results as an effective learning tool, but as students are trained to use imagery, the effects may increase.

4. Animation is a universally appealing and effective instructional tool. Computer generated animation has unique attributes beyond traditional animation. Multiple perspectives, movement through a mathematically defined three dimensional space, and ease of manipulating design elements set computer generated animation apart from other design tools. Most exciting for the artist is the realization of the seemingly limitless possibilities of this medium. Applications are equally unbounded.

A multiple approach to the investigation of a dynamic medium is indicated. The vigor of the technology and the creativity of the
designer are communicated through computer generated animation, yet the applications of the technology to learning are undeveloped and untested. Sensitivity to the nuances of both the medium and the learner is necessary for successful exploitation of a technology as powerful and promising as computer generated animation.
CHAPTER III
DESIGN AND METHODOLOGY

The focus of this study was the description and analysis of teachers' reactions to the following problem: given the state-of-the-art computer generated graphics as currently produced for commercial purposes and likely to be available for the classroom, what instructional uses and curricular impact could computer generated animation have? In order to investigate this problem, both qualitative and quantitative methodologies have been used. The intent of this study was not to control the variables of computer animation and test effects on an audience of teachers; instead, the intent was to have teachers describe their reactions to the graphics and to derive meaning from those descriptions. However, eliciting teachers' perceptions of these graphics was just the first step. Determining credibility required some triangulation, a method of confirming data. External observation of teachers' actions or comments is not quite enough (Olson, 1980); their intentions must be identified. To help establish credibility of the study's conclusions, semi-structured interviews provided preliminary data, and a Q-sort of statements elicited during the interviews was administered to the teachers in order to confirm the theory that appeared to emerge. Statistical analysis techniques of the Q-sort data allowed assessment of the
associations or links between those constructs elicited during the interviews (Bannister and Mair, 1968:28).

The inter-relationship of the components of the study is illustrated by Figure 4. The linkage between the instructional designer (or the researcher, in this case) and the teacher is tantamount to the assumptions of the study. Because of the teacher's expertise and sensitivity to the instructional needs of students, the teacher is considered an integral part of the investigative process. As Hinely and Ponder (1979) point out, teachers are now seen as contributing partners in the research effort, and there is a definite need to consult with this professional and experienced group (Common, 1983; Floyd, 1982:128; McCutcheon, 1982).

The most dynamic portion of the study is shown by the elements within the central portion of the figure: 1st interview, 2nd interview, data analysis, and Q-sort (see Figure 4). As described by Hammersley and Atkinson (1983:174), the analysis of data in ethnography is not a distinct stage in the research process. Rather, data analysis begins in the formulation of the research problem and continues right through the writing of the study. "Theory building and data collection are dialectically linked," they said. Although this study was not an ethnography, the principle of continuous data analysis holds. Consequently, data from the first interview served several purposes: 1) to be used directly in unmodified form as Q-sort items, 2) to influence content of the 2nd interview, 3) to be processed through analysis and then directed to the 2nd interview or to the Q-sort. Data from the 2nd
Figure 4: Model of Research Design
interview were also used directly as Q-sort items or processed through analysis. Q-sort data were subsequently put through a final analysis as were interview data. Data analysis was followed by data interpretation, and recommendations for further research and curriculum development were formulated.

The timeline for the completion of the study was:
1st interviews/Data analysis/2nd interviews—Spring Quarter 1985
Data analysis—Summer Quarter 1985
Q-sort—Fall Quarter 1985
Data analysis and interpretation—Fall and Winter Quarters 1985/86

Research Questions

The study addressed, but was not limited to, several a priori questions relative to the stated research problem:

1. What teacher variables such as experience, grade level taught, etc. interact with emerging constructs regarding use of these graphics?
2. How do teachers' selection of instructional materials affect perceptions of the utility of computer generated graphics?
3. What new content is identified for inclusion in the curriculum after seeing the graphics?
4. What is the nature of the newly included content?
5. What formal features of the medium are identified by the teachers?
6. Which of those formal features were determined by the teachers to be useful for instruction?

Questions that emerged from the interviews and that were incorporated into the design of the Q sort are listed below:
1. Does a teacher who recognizes and appreciates the dynamic properties of state of the art computer generated animation also view education as a dynamic system?

2. Will the propensity towards static or dynamic notions be consistent across all three categories of teacher concern (instructional role of the teacher, the role of instructional media, and sources of curriculum)?

3. How would a teacher who fundamentally views education as a static system construe the usefulness of a medium that succinctly models dynamic phenomena?

4. How will teachers order instructional role, instructional media, and curriculum on a static-dynamic continuum?

5. What superordinate concerns of the teachers does the clustering of statements reveal?

Sample

The population for this investigation was the teaching staff of the Groveport Madison Local Schools, a school district of approximately 5900 students, in Groveport, Ohio. The study sample consisted of eight practicing classroom teachers from elementary and junior high schools. The sample size was not pre-determined but was intended to reflect the number of participants needed to acquire consistent information.

Several factors supported the choice of Groveport Madison schools for the population base for this study. First of all, Groveport, Ohio, is part of a larger metropolitan area, Columbus, Ohio, whose demographics are such that the population is frequently used for test
marketing research. The Columbus metropolitan area is considered to be relatively representative of American lifestyles (McCarron, 1980). Secondly, the administration of the Groveport Madison schools was actively seeking cooperative research efforts between the school district and The Ohio State University. Such cooperation was seen by the school administration as an opportunity for staff development and curriculum innovation. The school district had not been previously involved in university research projects. The demographics of the community, the supportive administrative attitude, and the notion that the teachers would not have been overwhelmed by previous research projects made Groveport Madison Local Schools an attractive choice.

A combination of snowball sampling and purposeful sampling was used. Snowball sampling, a sampling technique that uses subjects to identify other appropriate subjects, was helpful in identifying those teachers who were not only willing to participate in this forum but were also identified by peers and supervisors as being perceptive and innovative teachers. The purpose is not to identify the best teachers but to access those that are thought to be among the best. Purposeful sampling, a method of sampling where particular subjects are chosen because they facilitate the developing theory (Bogden and Biklen, 1982:67), was used to test emerging themes. The initial recommendations came from the superintendent of the school district after he was contacted about the feasibility of the study (Appendix A). He suggested both an elementary principal and a middle school principal as ones who would be supportive of the research and who would have teachers on their staffs who would fit the sample criteria.
Potential participants were contacted by phone. Only one teacher contacted declined participation. After the initial contact was made, a letter of confirmation was sent (Appendix B) and a copy of promotional material from Cranston/Cauri Productions was included to provide some orientation for the teacher. Prior to the first interview, each teacher was asked to read, and sign, a permission form (Appendix C) that detailed the purpose of the research and the rights of the participant. At the conclusion of the study, a handwritten note of thanks and a packet of Post-It notes were sent to each participant as a token of appreciation.

Data and Instrumentation

Data were collected during two phases. The first phase consisted of each teacher individually viewing videotapes of computer generated animation and participating in semi-structured, focused interviews (Appendices D & E). The videotapes and the interviews were intended to provide a forum for teachers to experience and openly discuss these graphics in an environment that allowed their professional expertise to be creatively applied. Two interview sessions were proven to be necessary because the novelty of the graphics is somewhat constraining to creative thought. A pilot study that consisted of showing the videotapes and conducting group interviews pointed to the need for two interview sessions. The animated graphics were generally novel and sometimes overwhelming to the participants, and time was needed to allow the new images to be accommodated in the mental schema of the participants.
The majority of the computer generated three dimensional animated graphics to be used in this study have been produced by Cranston/Csuri Productions, Inc., Columbus, Ohio, and the Computer Graphics Research Group, The Ohio State University. Videotapes shown during the first interview were "Medical Demo" and Siggraph '84. These videotapes from Cranston/Csuri Productions were produced as demonstration graphics to be shown to potential commercial clients. Excerpts include major network logos, computer generated imagery of the human body produced for Goldcrest Films' The Living Body, and TV spots for major advertising firms. Permission to use 3/4" videotapes and 1/2" duplicates of the graphics was secured from Patricia Moore, Communications Director of Cranston/Csuri Productions, Incorporated.

Videotapes used for the second interview were "Snoot and Muttly", the "Cube", and "Taxi". Students from the Computer Graphics Research Group, directed by Charles Csuri, produced "Snoot and Muttly", the winner of the Japanese International Gran Prix computer animation award. "Taxi" was produced by Dr. Thomas Linehan to demonstrate interactive properties of an animated lesson on map reading skills. Permission to duplicate the videotapes in both 3/4" and 1/2" format was granted by Dr. Thomas Linehan, Associate Director of the Computer Graphics Research Group. Computers used to generate the images are VAX-11/780's and VAX-11/750's.

The "Cube" was a replication of a Children's Television Workshop animated sequence. This computer animation was used in research under the direction of Dr. Marjorie Cambre of The Ohio State University and was produced with the College of Education's computer graphics
animation system which is under the direction of Dr. John Belland. The computer used to produce the animation was a PDP 11/23+.

These interviews elicited values about curricular content as well as instructional possibilities that state of the art computer generated graphics may offer. Flagg (1981), however, has reported that an inductive approach to identify program features has not been as successful as desired; the results tend to be local and yield terms with which producers are not familiar. On the other hand, the a priori approach, an approach that uses an already existing taxonomy of program features, tends to yield strong correlations between the terms and audience perception. A strong argument can be made for the inductive approach, however, if one considers the need to consider the viewer from his own vantage point, "being careful and respectful at each step not to intrude upon his reality with our own, and not to impose our theoretical constructs on his meanings" (Monaghan, 1968). An even stronger argument must then be made to ensure the trustworthiness and hardness of the constructs that are elicited. It is not the intent of this study to present results that are so local as to not be useful beyond the chosen population. A second phase was consequently employed in order to strengthen the credibility of the first phase's results.

The second phase of the study was intended to test and extend the hypotheses that emerged. For this phase, a structured, forced, Q sort was administered to each member of the sample. Q methodology has been cited for its heuristic quality and usefulness in exploratory research (Kerlinger, 1973:594). Additionally, Emmert (1970:163) pointed out the value of complementarity of methods, that is, the
manner in which the combination of diverse descriptions of the same phenomenon gives a more complete picture. The Q sort was intended to complement the focused interviews as well as provide a form of triangulation of the data.

The items for the Q sort were determined by the themes, hypotheses, and statements that emerged from the focused interviews as well as from the literature that supported those themes. The Q sort then became a test of theory that the interviews elicited.

Analysis of the Data

Data were provided by the two interview schedules and the Q sort. Both the interviews and the Q sort were thought to be appropriate for the purpose of this study which was to explore through teachers' constructs the possible impact of state-of-the-art computer generated graphics on the elementary and junior high school curriculum.

Analysis of the data used methods consistent with the exploratory nature of the study. The demographic data supplied by the interviews are reported in terms of measurement for central tendency. The rest of the interview data were content analyzed for the types of instructional uses of the graphics suggested by the teachers and for the factors that may inhibit or enhance use.

The Q sort data were analyzed in two ways. The Q sort data were initially subjected to statistical analysis using the SPSSX computer program. In order to detect similarity between persons, a measure of the Pearson product-moment correlation coefficient was performed on the Q sort distributions.
The Q sort data were also analyzed with item-by-item placement comparisons. Ratings were compared so those items that were consistent in placement could be examined for meaning.

Human Subjects Program

According to the Digest of Human Subject Program Guidelines (Appendix, Section 3), The Ohio State University, studies exempt from review include those that involve survey and interview procedures with subjects over 18 years of age. Consequently, this study did not need to be submitted to the OSU Human Subject Review Committee.

Limitations

The population used in the study was limited to one suburban school district, and the sample was self-selective in that the participants were identified by peers and administrators as being innovative and enthusiastic teachers. Because most nominators assumed the nature of the study concerned computers rather than computer graphics, the majority of the teachers interviewed were also computer users. The results of the study consequently need to be limited to the population studied, and generalization to teachers in general must be guarded.

The novelty of the computer animation shown to the participants both inhibited response and most likely affected the nature of their reactions. The content and order of the animations also appeared to affect response. The teachers were much more responsive to instructional animations and less responsive to those that were
expressive or persuasive (e.g. commercials) in nature. Choice of stimulus materials therefore limits the generalizability of the results.

Summary

The approach used in this study was a first step in exploring the instructional applications, curricular impact, and factors of utilization of an emerging technology. The instrumentation and methods of data collection were intended to reflect the exploratory nature of this research. Outcomes of this study were also intended to include recommendations for the generation of computer graphic animations that could be tested experimentally for cognitive effects. With reservations, conclusions may be used temporarily as guides for instructional design as technology now permits and expanded upon as technology evolves. As either present or future use, the results of the study will provide a glimpse into the unknown between instructional design and emerging technology. Furthermore, implications for curriculum change and teacher involvement with curriculum reform and instructional design are also intended outcomes.
CHAPTER IV
PRESENTATION AND ANALYSIS OF DATA—THE INTERVIEWS

This chapter presents the data collected during the interviews. The interviews served several functions in the search for teacher perceptions of the instructional utility and form of computer generated animation. First of all, there was a heuristic function of the interviews; that is, the interviews were used to search for ways this new technology could be used given present knowledge and objectives. These applications center upon new ways of delivering the content of the current curriculum. These have been metaphorically called "old wine in new wine-skins" applications.

The second function of the interviews was to provide data that was maieutic in nature. The maieutic process, which describes a Socratic method of eliciting new ideas, is one in which new applications of the technology are identified. The goal was to help teachers identify new curricular content that is now possible, or newly valued, given this technology.

The third and last function of the interviews, and the Q sort as well, was to identify and examine the social and educational effects of the application of the new technology. This manner of interpretation and analysis, called hermeneutics, seeks to identify the changes that the new technology would have upon the assumptions of traditional
education. How might notions about teaching and what is to be taught be altered by the availability of state of the art computer generated animation? Just as people's notions about the Earth were forever altered by pictures of an "earthsat" taken from the Moon's surface, the impact of new visual experiences rendered by computers may also be significant in ways yet to be identified.

The interviews coincided with the viewing of computer generated animations and were structured in such a manner as to take advantage of any opportunities to acquire relevant information. An interview schedule was used, but if a participant's answer seemed incomplete or suggestive of pertinent information that was unexpected, then the questioning would turn to clarification or expansion of that statement. The second of the two interviews was also kept flexible in order to expand or clarify notions that were expressed. As a result of the flexibility of the interviews, no two teachers had identical interviews or viewing experiences. References to the teachers' observations are therefore to be understood in terms of the varying opportunities for response. Finally, observational notes were kept in addition so that confounding conditions such as tiredness (a common state of the participants!) or poor video display would be recorded.

Since the number of participants was not decided before the study, redundancy in responses was used as the criteria for ending the search for participants. Periodic assessment of the interview data determined whether redundancy was present even after purposeful sampling to provide contrasting information. After six weeks of interviewing, sampling ended. Although the suggestions for use of the graphics
continued to be varied, there would have been as many suggestions as there would have been participants. However, the type of suggestions and the context of those suggestions began to form into categories.

The analysis of interview data yielded five categories of information. Two of the categories provide contextual information that help explain the basis for the teachers' reactions to the graphics: characteristics of the participants and media factors that would inhibit or encourage teachers' adoption of computer animation. The other three categories deal directly with the form and functions of the graphics: applications for the current curriculum, new curricular content, and social and educational effects. The Q sort, which was derived from the interviews and which is described in Chapter Five, expands upon the notion of the social and educational effects of implementation of three dimensional computer generated animation.

It is with a sense of impatience that this investigator reports the teachers' suggestions for use of the graphics for it is the nature of the suggestions that is the most substantive portion of this investigation. Most teachers are not trained in the systematic design of instruction, nor do they use a prescriptive model of design when designing their own materials (Kerr, 1981). A list of teachers' suggestions may prove to be disappointing to the creative computer graphics designer or the innovative instructional designer if what they are looking for are new topics to be implemented into the curriculum via computer graphics. The teachers interviewed are, however, sensitive to the effects of schooling on their students and the needs of the society in which these students will be participating;
therefore, the rich applications the teachers saw in the graphics were not of topic but of kind: the kind of educational environment that could be fashioned for their students.

Characteristics of the Sample

The final sample consisted of three elementary and five middle school teachers that were nominated for interviewing by their peers or administrators. These teachers were identified as being perceptive, innovative teachers and ones that would be interested in the purpose and results of this study. Additionally, the buildings where these teachers taught were managed by principals that the superintendent had characterized as excellent, a judgment that the teachers upheld.

The appearance of the buildings and the educational climate within the buildings indicated that the superintendent was correctly proud of his personnel. The elementary building had, in fact, just been awarded the Governor's Award for Excellence the day before the first interview.

All but one of the teachers who were called participated in the interviews and Q sort. The teachers were willing participants but some were initially skeptical of the process. A typical question was, "How long will this take?" As a former elementary teacher, this investigator was aware of the importance of planning periods or free time for "recovery" from the tasks at hand and so was uneasy about asking them for their time. Fortunately, the 30-45 minute time range given the teachers seemed to be acceptable. In addition to the small time commitment, the teachers also seemed to appreciate the opportunity to express their expertise. They concurred with a premise of the study
that teachers ought to have a part in the design of innovative materials that they are going to be asked to implement.

The average age of the teachers was 35.6 years and the average length of experience was 12.6 years. Table 1 summarizes the demographics of the sample.

**TABLE 1**  
**DISTRIBUTION AND DEMOGRAPHICS OF PARTICIPANTS**

<table>
<thead>
<tr>
<th>#</th>
<th>Sex</th>
<th>Age</th>
<th>Years</th>
<th>Education</th>
<th>Grade/Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>35</td>
<td>14</td>
<td>MA+</td>
<td>6-8 Math</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>36</td>
<td>13</td>
<td>MA+</td>
<td>6-8 SS</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>37</td>
<td>15</td>
<td>BA</td>
<td>Kindergarten</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>34</td>
<td>11</td>
<td>MA+</td>
<td>7 LA</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>34</td>
<td>13</td>
<td>BA+</td>
<td>1st Grade</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>41</td>
<td>17</td>
<td>BA</td>
<td>Third Grade</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>31</td>
<td>9</td>
<td>BA</td>
<td>7-8 Science</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>39</td>
<td>9</td>
<td>BA+</td>
<td>7-8 Science</td>
</tr>
</tbody>
</table>

n=8 6 Females $\bar{x}=35.6$ $\bar{x}=12.6$  
2 Males
The professional experiences of the participants varied, although seven of the eight had indicated that they had served, or were currently serving on curriculum committees. One teacher had had several years business experience between teaching assignments, two others had been or were responsible for the computer courses at their respective schools. The First Grade teacher became guidance counselor during the summer.

Use of Instructional Media

One of the first steps in determining the perspective from which the participants were viewing the graphics was taking an inventory of the type of instructional media the teachers currently used. The participants were given a card that listed fifteen items of instructional media (Appendix D) and asked to describe the frequency each item was used: daily, weekly, monthly, or yearly. This activity served two purposes. First of all, in order to place in context the teachers' reaction to a particular instructional medium such as computer generated animation, it was necessary to know the nature of instructional media that the teachers already used on a regular basis. Secondly, the pilot study with eight teachers demonstrated that they did not use a variety of media, and their perceptions of the use of computer graphics were limited to the media they favored; the presentation of the list was also intended to expand their notions of instructional media.

The list apparently evoked strong feelings about media, because the teachers responded quickly, decisively, and occasionally with
comments that revealed negative opinions of particular media. A bad experience with workbooks, for instance, caused one teacher to react strongly to that item on the list. The majority of the teachers were not at all familiar with videodisc and consequently had no reaction to that item. Table 2 illustrates the teachers' responses.

The interpretation of this self report is limited in that the teachers were relying upon a mental reconstruction of past events. The report must also be interpreted in light of the realities of the availability, accessibility, and usefulness of instructional media. Teachers plan from available materials, and the use of materials is directly related to their accessibility, determined by the materials being physically housed in the building (Taylor, 1980). The availability of delivery systems for instructional materials would have similar consequences.

The usefulness of materials in the teacher's instructional role is another important component in teachers' choices of media. Taylor found that a factor central to teacher selection of materials was the extent to which materials help engage the interests and energies of the students. Teachers feel that if they have the attention of their students, those students will learn. Again, the delivery system that holds most appeal for students will be utilized. Student enthusiasm for computers, for instance, has encouraged teacher adoption. As one of the participants of this study indicated about the usefulness of television, "If TV is the medium that will hold their attention, then that is what I will use." The participants in the study repeatedly voiced the appeal that television has for their students.
### TABLE 2

**PARTICIPANTS' USE OF INSTRUCTIONAL MEDIA**

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency of Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
</tr>
<tr>
<td>Texts</td>
<td>4</td>
</tr>
<tr>
<td>Worksheets/paper</td>
<td>8</td>
</tr>
<tr>
<td>Chalk &amp; chalkboard</td>
<td>5</td>
</tr>
<tr>
<td>Overhead projector</td>
<td>2</td>
</tr>
<tr>
<td>Tape recorder</td>
<td>2</td>
</tr>
<tr>
<td>* Film projector</td>
<td>-</td>
</tr>
<tr>
<td>* Computer</td>
<td>1</td>
</tr>
<tr>
<td>Opaque projector</td>
<td>-</td>
</tr>
<tr>
<td>Slide projector</td>
<td>-</td>
</tr>
<tr>
<td>* Television</td>
<td>2</td>
</tr>
<tr>
<td>* Video cassette recorder</td>
<td>-</td>
</tr>
<tr>
<td>Posters/pictures</td>
<td>6</td>
</tr>
<tr>
<td>Record player</td>
<td>2</td>
</tr>
<tr>
<td>* Videodisc</td>
<td>-</td>
</tr>
<tr>
<td>Filmstrip projector</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: The media marked by an asterisk (*) are those media that are appropriate delivery systems for computer generated animation.*
An analysis of the context in which the teachers operate thus determine the interpretation of their use of media. Two participants were Kindergarten and 1st Grade teachers who would consequently not ordinarily use textbooks for instruction. The use of television was a bit more complex. From observation of the media centers where the interviews were conducted in the schools, television receivers were readily available at each of the schools and appeared to be used frequently. The schools' librarians were responsible for the distribution of equipment. The sample of teachers, however, did not use the TV's on a regular basis, and the two daily users of television were elementary teachers. Another instructional medium, the computer, was just beginning to be implemented into the school district. According to the participants, the lack of software and knowledge were the main inhibitors of the use of the computers. The one daily user was the middle school computer teacher, and the two weekly users were elementary teachers, one of whom had been responsible for implementing computer literacy into the math curriculum. As mentioned before, there were no videodiscs or videodisc players in the school system.

The results of the inventory of media use could be examined from the perspective of projected use of computer generated animation. As shown in Table 2, those media that are appropriate delivery systems for computer animation are: film projector, computer, television, video cassette recorder, and videodisc. Assuming that daily, weekly, or even monthly use indicates teacher acceptance of an instructional medium as well as availability of that medium, the results show that delivery systems appropriate for computer animation are used somewhat
frequently. The exceptions are, of course, computers and videodisc which are not readily available. The film projector was mentioned to be used at least monthly by 88% of the teachers, television by 50%, and the video cassette recorder by 50%. Frequent use of these media indicates that the manner of delivery of computer generated animation would not interfere with adoption.

**Selection of Computer Animation as Instructional Materials**

Given the fact that the delivery system would not interfere with the use of computer animation as an instructional tool, the next issue to examine would be the nature of the graphics as instructional materials and how they relate to what is known about teacher selection of materials.

Taylor (1980) presents five questions, listed below, that teachers ask when considering the use of instructional materials.

1. "Will these materials be available when I want to use them?"
2. "Is prep time reasonable?"
3. "Are these materials compatible with my classroom management style?"
4. "Will these materials help me engage the interests and energies of my students?"
5. "Are these materials within my curricular area?" (p. E-3)

If planning for the use of instructional materials is too complicated or required too far in advance, the teachers indicated that use of materials is inhibited. One teacher in the pilot study said concisely what some of the other teachers inferred, "If you have to
know three weeks in advance of what hour of the day you need it, it isn't worth it...I couldn't say to you that three weeks from tomorrow I want Tape A at 2 o'clock." Availability and reasonable prep time do address the need teachers have for immediacy. They are more interested in being able to quickly respond to student reaction (Doyle and Ponder, 1977).

Compatibility with classroom management style is another question teachers ask when selecting materials. Judging from the comments of the participants, computer animation delivered via television, video cassette recorder, or film fits this criterion. Favorable comments towards the use of this type include the opportunities for whole class instruction as well as individualized study centers, the addition of another tool to the range of instructional choices, and, in the case of videotape, the ability to review and proceed at will throughout a presentation and discussion.

A very important question for teachers concerns whether or not materials help the teacher engage the interests and energies of the students. First of all, the teachers repeatedly mentioned how appealing animation in general, and the computer animations specifically, are. Appeal was measured by the teachers in terms of color, movement, sound effects, and complexity. The desirability of complexity, however, was in direct proportion to the age of the student considered to be viewing the graphics; the teachers of young children found the simplicity of Medical Demo to be an asset, and the middle school teachers found the simultaneous movement of several objects in the Cranston/Csuri tape to have powerful attention-getting properties.
Where some teachers may rebel against yielding to stimulating media that kids find so appealing, these teachers generally indicated that they would want to recognize and utilize the strong appeal these graphics have.

The graphics were also appealing to the teachers because of the familiarity of the delivery system. Television, as stated before by several teachers, is a favored medium with children, and as one teacher commented, its familiarity encourages concentration on the content rather than promoting distraction with a novelty effect. Immediately upon stating the advantages of television, however, one teacher expressed the concern that students equate television with entertainment and such expectations lower concentration.

The teachers also recognized the power of learning from visuals, and they acknowledged the benefit the animated graphics would have for those who learn primarily in the visual mode and for those who need to learn to use the visual mode. This particular attribute spoke to the teachers' need to address the different learning styles of their students.

The fifth question that teachers ask, according to Taylor, concerns how well instructional materials fit the curriculum. Not only must the teacher decide if materials are appropriate for the curriculum, but the teacher must decide whether or not the topic is one he or she cares to teach. The applications of computer generated animation to the curriculum is a question central to this study and is an issue that is inevitably going to be examined by teachers when implementation begins.
Applications to the Current Curriculum

Before viewing the videotapes of computer animation, the teachers were asked about the appropriateness and applications of animation. The teachers collectively spoke to most of Caldwell's (1978) assessment of the educational advantages of animation: the ability to control visual stimuli and the propensity for animation to attract attention. The teachers' perceptions of the practical uses of animation both before and after exposure to the computer animations also closely matched those uses outlined by Caldwell: entertainment, demonstration of what can't be seen in real life, portrayal of embarrassing subject matter, exaggeration of critical information, and the addition of humor.

Because of its educational intent, the medical demonstration animation elicited many responses regarding the usefulness of animation. One teacher remarked that the three dimensional images were the next best solution to "unzipping the skin" to show what mysteries of the human body were hidden from our eyes. Other teachers found the isolation of an organ from its surroundings as well as the replacement of that organ into its setting a helpful tool in understanding the relationship between part and whole. Although one teacher mentioned that the realism of the graphics may be offensive to students of a significantly conservative religious sect, most teachers appreciated the manner in which the images depicted the human body with a high degree of fidelity without the realism of photography.

Teachers' observations as to appropriate applications of computer animation to the current curriculum are presented in two parts: the
direct application of the graphics as viewed on videotape by the teachers (see Table 3), and the redesign of the graphics to meet instructional needs (see Table 4). Some of their suggestions reflect current practices in traditional animation techniques, but like the suggestion for modeling plate tectonics (which was considered to be ineffective when seen animated by traditional means), teachers saw the potential for more complex modeling of dynamic phenomena.

In order to reflect both the content and the nature of the teachers' observations, the suggested applications are reported in terms of the instructional activity, the type of learning the activity promotes, and the advantages that three dimensional computer animation have over traditional forms of instructional visuals (see Tables 3 and 4).

Gagne (1985) classifies types of learning (or learning outcomes) into five categories: intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes. Intellectual skills, for instance, entail how one learns to interact with the environment using symbols. These intellectual skills utilize sub-skills that are interdependent, and each subcategory serves as a prerequisite for the preceding one. Thus, discriminations precede concepts that require rules as prerequisite skills. The rules are consequently used as prerequisite skills for higher-order rules. Cognitive strategies, on the other hand, are the skills that learners use to regulate their own intellectual processes such as attending, learning, remembering, and thinking. Verbal information is that which can be stated or told about and is important because it provides
# Table 3

## Applications of Computer Animation to the Current Curriculum

<table>
<thead>
<tr>
<th>Instructional Animation</th>
<th>Learning Outcome</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Heart pace affected by exercise *</td>
<td>Intellectual: Rule</td>
<td>Modeling a dynamic system</td>
</tr>
<tr>
<td>2. Removing skeletal part for closer examination, replacing part *</td>
<td>Intellectual: Discrimination</td>
<td>Maintaining referent; Cost effective</td>
</tr>
<tr>
<td>3. Following change in viewpoint</td>
<td>Intellectual: Rule</td>
<td>Multiple perspective</td>
</tr>
<tr>
<td>4. Map reading from different perspectives *</td>
<td>Intellectual: Discrimination</td>
<td>Transition from reality to paper; provides surrogate practice in moving through space</td>
</tr>
<tr>
<td>5. Rotation of objects *</td>
<td>Intellectual: Concept</td>
<td>Superior to 2D images; no confounding stimuli</td>
</tr>
<tr>
<td>6. Demonstrate networking *</td>
<td>Intellectual: Rule</td>
<td>Demonstrates interrelationship</td>
</tr>
<tr>
<td>7. Language experience</td>
<td>Verbal</td>
<td>Good source of activation</td>
</tr>
<tr>
<td>8. Art appreciation</td>
<td>Intellectual: Concept; Attitude</td>
<td>Serves as exemplar, source of activation</td>
</tr>
<tr>
<td>9. Advanced organizer for creative writing</td>
<td>Cognitive strategies Discrimination</td>
<td>Ambiguity encourages semantic processing</td>
</tr>
<tr>
<td>10. Provide practice in looking at things from different perspectives *</td>
<td>Attitude; Intellectual: Concept</td>
<td>Unlimited perspective</td>
</tr>
<tr>
<td>11. Provide examples of change in perspective (art) *</td>
<td>Intellectual: Rule</td>
<td>Demonstrates how change in perspective alters shapes</td>
</tr>
<tr>
<td>12. Provides an example of human expression</td>
<td>Intellectual: Concept; Attitude</td>
<td>Novel and imaginative use of a medium</td>
</tr>
</tbody>
</table>

Key to superordinate concept being developed by the animation:

* Cause & Effect  
# Concurrent Operations  
* Part to Whole
### TABLE 4

**EXTENDED APPLICATIONS OF COMPUTER ANIMATION TO THE CURRENT CURRICULUM**

<table>
<thead>
<tr>
<th>Instructional Animation</th>
<th>Learning Outcome</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rotation of globe on axes *</td>
<td>Intellectual:</td>
<td>Dynamic representation of the change in seasons</td>
</tr>
<tr>
<td></td>
<td>Rule</td>
<td></td>
</tr>
<tr>
<td>2. Color coding demographics on map *</td>
<td>Intellectual:</td>
<td>Shows influence of geographical location</td>
</tr>
<tr>
<td></td>
<td>Discrimination</td>
<td></td>
</tr>
<tr>
<td>3. Modeling correct behavior, i.e. skipping</td>
<td>Motor</td>
<td>Availability, visual referent</td>
</tr>
<tr>
<td>4. Compare solid &amp; plane geometric shapes</td>
<td>Intellectual:</td>
<td>Interpolation provides translation from 2D to 3D</td>
</tr>
<tr>
<td></td>
<td>Discrimination</td>
<td></td>
</tr>
<tr>
<td>5. Model functions of nouns and verbs</td>
<td>Intellectual:</td>
<td>Demonstrates complexity and dynamism of language</td>
</tr>
<tr>
<td></td>
<td>Rule</td>
<td></td>
</tr>
<tr>
<td>6. Three dimensional sentence diagramming</td>
<td>Intellectual:</td>
<td>Exemplar of dynamic system</td>
</tr>
<tr>
<td></td>
<td>Discrimination, Rule</td>
<td></td>
</tr>
<tr>
<td>7. Model functions of the brain during the writing process * #</td>
<td>Intellectual:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concept; Attitude</td>
<td></td>
</tr>
<tr>
<td>8. Animate words to demonstrate meaning</td>
<td>Intellectual:</td>
<td>Makes abstract meanings more concrete</td>
</tr>
<tr>
<td></td>
<td>Concept</td>
<td></td>
</tr>
<tr>
<td>9. Model the formation of cursive letters</td>
<td>Motor</td>
<td>Eliminates interference from hand position, fluidity</td>
</tr>
<tr>
<td>10. Provide moving examples of animals' tracks *</td>
<td>Intellectual:</td>
<td>Availability of exemplars</td>
</tr>
<tr>
<td></td>
<td>Discrimination</td>
<td></td>
</tr>
<tr>
<td>11. Compare circulatory systems of animals * #</td>
<td>Intellectual:</td>
<td>Availability, dynamic modeling</td>
</tr>
<tr>
<td></td>
<td>Discrimination, Rule</td>
<td></td>
</tr>
<tr>
<td>12. Demonstrate chemical bonding * #</td>
<td>Intellectual:</td>
<td>Can see what is hidden from the human eye</td>
</tr>
<tr>
<td></td>
<td>Rule</td>
<td></td>
</tr>
<tr>
<td>13. Animate cellular life forms *</td>
<td>Intellectual:</td>
<td>Provides controlled examination</td>
</tr>
<tr>
<td></td>
<td>Discrimination</td>
<td></td>
</tr>
<tr>
<td>14. Examine properties of crystals</td>
<td>Intellectual:</td>
<td>Availability, close examination</td>
</tr>
<tr>
<td></td>
<td>Discrimination</td>
<td></td>
</tr>
<tr>
<td>15. Demonstrate plate tectonics * #</td>
<td>Intellectual:</td>
<td>Modeling of a dynamic phenomenon</td>
</tr>
<tr>
<td></td>
<td>Rule</td>
<td></td>
</tr>
</tbody>
</table>

Key to superordinate concept developed by animation:

* Cause and Effect  # Concurrent Operations  " Part to Whole
factual information upon which more complex knowledge is built. The fourth category is motor skills, composed of a sequence of movements particular to the desired task. Handwriting would be appropriately categorized as a motor skill. The final learning outcome described by Gagne is attitude, defined as an internal state that influences choices of personal action (p. 63).

Tables 3 and 4 presume that the learner has the necessary prerequisite skills in order to fully utilize the instructional events that will lead to the learning outcome. Furthermore, the instructional animations identified or suggested by the teachers would presumably provide the conditions of learning that were necessary for accomplishment of the task. The internal and external conditions of learning represent those conditions under which a particular type of learning optimally occurs. The internal conditions of the learner reflect the prerequisite skills the learner must have in order to perceive and process incoming information. The external conditions of learning refer to those conditions that are arranged for the learner and that influence internal information processing, i.e. cuing techniques and the use of exemplars. The contribution of the computer animations is to provide appropriate conditions of learning.

Gagne is careful to point out that there is no assigned value to the outcomes of learning; the categories are simply differentiated capabilities and are arbitrarily ordered in description (p. 66). For the purposes of this data analysis, however, it is important to note that the predominant applications for the graphics perceived as useful and desireable by the teachers are learning outcomes that fall under
intellectual skills. Intellectual skills call upon more complex cognitive processing than does verbal information. Additionally, the subskills under the intellectual domain are ordered by Gagne according to the complexity of the mental task. Concept learning and rule learning, requiring more complex cognitive processing, are more often identified with applications of the graphics than is discrimination learning.

Attitude is another learning outcome identified several times to be appropriately promoted by computer graphics. Gagne (1985:63-64) stresses the effects of attitude upon the behavior of an individual. That is, the choices of action by an individual are determined, in large part, by attitude. Furthermore, the development of attitude is dependent upon other learning outcomes such as intellectual skills or motor skills. In order to like mathematics problem solving, one needs to have the prerequisite computational skills; in order to develop an appreciation for art, one needs the prerequisite skills of identification and judgment. Likewise, attitude as a learning outcome in Tables 3 and 4 is always accompanied by other learning outcomes.

Although the applications of the viewed graphics are, in large part, determined by the intent and talent of the designers, the teachers' observations are important for three reasons. First of all, the teachers recognized the usefulness of the images for the activation of higher cognitive processes. Secondly, the teachers' recognition of those attributes also indicates that higher cognitive processing is a valued instructional activity. If innovative and well-designed material is neither recognized nor valued, that material will not be
implemented. Third, the teachers' suggestions for instructional images that the graphics inspired but did not depict (see Table 4), continue the pattern of utilizing the graphics for more complex learning tasks.

The nature of the graphics applications can also be analyzed in terms of the types of concepts that the images develop. Many of the images model cause and effect (see asterisks, Tables 3 and 4). In addition, some of the images also model concurrent activities (see pound signs, Tables 3 and 4). The relationship of a part to its whole (see carats, Tables 3 and 4) also emerged as a mathegenic attribute of the computer animations. Both cause and effect, and concurrent activities, as well as part to whole relationships, are integral components of dynamic systems. Dynamic systems, as opposed to static systems, represent interdependent, causal relationships. The modeling of dynamic phenomena seemed to be the most outstanding attribute of the graphics that the teachers valued. The interest in these particular attributes of three dimensional computer animation had two sources: educational goals and availability. The teachers indicated the need for more instruction in process and the meaning of processes. The teachers also said time and again that they did not have the appropriate tools for demonstrating, or for student experimentation with, many dynamic phenomena. Consequently, the single most important contribution of computer generated animation to the curriculum would be to increase, and extend, the opportunities for modeling realities that are hidden from the human eye and model possibilities that are inhibited by reality.
The Influence of Computer Graphics on the Curriculum

The teachers generally were not able to readily identify possible new curricular content given the availability of computer animation as an instructional tool. Most comments centered upon the need, and predisposition, to follow the current curriculum. This "devotion" to the current curriculum could be explained in two ways. First of all, several of the teachers were members of curriculum committees and felt that they had played a role in developing the curriculum that they were delivering. Teacher input is crucial for acceptance and adoption of curriculum reform (Common, 1983). Secondly, the teachers appeared, as a group, satisfied with the curriculum. Even if a teacher said, "We are given this curriculum that we must follow," there was little indication that the given curriculum was inadequate. Most frustration regarding the curriculum centered upon the inadequate time available for delivering the content that was required.

The teachers apparent lack of suggestions for altering the curriculum, however, does not indicate a lack of imagination on the part of the teachers nor do the lack of suggestions reflect the perfection of the state of the curriculum. By examining the teachers' comments upon the perceived attributes of the graphics, one can infer that the content of the curriculum is less an issue than the nature of the content. Body systems are an important component of the middle school science curriculum. New insight into the operation of body systems can illustrated by animated, three-dimensional, color graphics. As stated before, the teachers repeatedly identified the ability of computer animation to model dynamic processes as a powerful
instructional tool. In *Mindstorms*, Seymour Papert posits that what an individual can learn, and how he or she learns it, depends upon the model provided (Papert, 1980:vii). The teachers apparently are cognizant of the value of higher order thinking and would like to be able to provide the models appropriate for developing those skills.

**Summary**

This chapter presented the data collected during the interviews and video tape viewing. The interviews with teachers served several functions: to search for ways state of the art computer generated graphics could be used within the current curriculum, to identify new applications for the graphics, and to identify and examine the social and educational effects that this new technology would have upon the assumptions of traditional education.

Several conclusions can be drawn from the analysis of the interview data. First of all, the manner of delivery of computer animated graphics would apparently not interfere with adoption of the graphics as instructional tools. The teachers interviewed are generally comfortable with television, film, and videocassette as instructional media. Secondly, the graphics had a great deal of personal and professional appeal. At the personal level, the teachers simply enjoyed the visual experience that the graphics provided, and they consequently felt that their students would also enjoy the images and attend to them. The teachers also saw in the graphics the opportunity to model concepts that are difficult, if not impossible, to explain verbally. The inadequacy of verbal instruction reflects not
only the nature of the concept, such as chemical bonding, but the learning style of some students who need iconic representation of an abstract concept. The teachers saw in the graphics the ability to address instructional topics that can only be presented visually and to also address the student who needs to learn in the visual mode.

The suggestions for using the graphics to deliver the current content of the curriculum were numerous, but the suggestions for new applications were limited. This allegiance to the current curriculum could be explained, in part, by the participation of some of the participants as curriculum committee members. They felt they had played a role in developing the curriculum that they were delivering. The other teachers were generally satisfied with the content of the curriculum; time to teach it was their main complaint. Teachers are also not trained as instructional designers, and the ability to extrapolate beyond their day-to-day concerns runs counter to their need for immediacy.

It is the importance of the nature of the identified instructional uses of the graphics that is the third conclusion of the interview data. The teachers seemed to recognize the usefulness of the images for the activation of higher cognitive processes. This recognition, in turn, indicates that the teachers recognize the value of higher cognitive processing as a meaningful instructional activity. The teachers repeatedly identified the graphics as a way of modeling cause and effect, concurrent operations, and the relationship of part to whole. These superordinate concepts lend themselves to the modeling of
dynamic systems, a phenomenon that is difficult to represent given current instructional media.

The teachers' interest in dynamic models of teaching and learning that the computer generated graphics allow was a major outcome of the interviews. The affirmation and examination of their interest as well as the educational and social implications of integrating their model of instruction, however, was accomplished by the Q sort, described in Chapter V.
CHAPTER V

METHODOLOGY AND PRESENTATION OF THE DATA: THE Q SORT

This chapter presents the methodology and construction of the Q sort that grew out of the interviews and resultant data. Although teachers' constructs regarding instructional role, instructional media, and curriculum emerged during these interviews, the superordinate construct "dynamic systems" was interwoven throughout their statements and consequently provides coherence and meaning to the data.

Dynamic systems is a term that reflects the properties and processes of both the graphics and the teachers' reactions to them. Because a system is defined as a regularly interacting or interdependent group of elements forming a unified whole, and dynamics are marked by continuous productive activity or change, dynamic systems would thus incorporate a holistic, changing, and interrelated notion of activity. Dynamism was expressed by the teachers in their notions of instruction, curriculum, and media; dynamism also describes a unique characteristic of state of the art computer generated graphics. The properties of three dimensional animated graphics allow the representation of complex phenomena such as the nervous system or the circulatory system. A dynamic representation of these systems shows the ecological balance and reciprocity between the elements of a system. Could it be that a teacher who recognizes and appreciates the
dynamic properties of state of the art computer generated animation would also view education as a dynamic system?

However, because both similarity and contrast are inherent in any construct (Bannister and Mair, 1968:14), the bipolar nature of dynamism must be recognized. Kelly (1966) as quoted by Bannister and Mair (1968:19) said, "If we are to understand a person's statement we had better take into account just what he felt he must negate, as well as what he used as the subject or predicate of his sentence." If a person's constructs reflect the properties of dynamic systems, then what is being rejected are the properties of static systems. Static is defined as showing little change. The circulatory system would be represented as a mechanical pump rather than as an organismic model. How does a teacher who views education as a static system construe the usefulness of these electronic images?

Another consideration emerges when one ponders Kelly's Fragmentation corollary to his Personal Construct Theory: "A person may successively employ a variety of construction subsystems which are inferentially incompatible with each other" (Kelly, 1963:83). Will the teachers who were interviewed show consistent bias for dynamism? How will the subsystems' constructs regarding curriculum, instructional role, and instructional media be ordered on the dynamic-static continuum? Will these orders correspond with the teachers' apparent recognition and appreciation of computer generated animation for education?
Construction of the Q Sort

A two by three structured Q sort was designed to investigate the manner in which the interviewed teachers' philosophical orientation (A) affects perception of function (B). As shown by Table 5, the levels of orientation (A) are static and dynamic, and the levels of function are curriculum, instructional role, and media.

<table>
<thead>
<tr>
<th>Independencies</th>
<th>Levels</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Orientation)</td>
<td>(a) dynamic (b) static</td>
<td>1</td>
</tr>
<tr>
<td>B (Function)</td>
<td>(c) curriculum (d) role (e) media</td>
<td>2</td>
</tr>
</tbody>
</table>

How the levels of curriculum, instructional role, and instructional media can be described as dynamic and static phenomena is central to this Q Sort. The explication of each level as it relates to the study follows.

Curriculum

The focus for this portion of the Q-sort was the definition of curriculum as well as the sources of and influences upon curriculum: society, the world of knowledge, and the nature of the learner. In a dynamic construct system, social phenomena and the manner in which people learn are perceived organically and as a system that is in constant flux and involved in relational change. The world of
knowledge is also perceived holistically. Knowledge is seen as an integrated body of knowledge; each bit of information is somehow influenced or connected to another. People of this mindset would tend to define curriculum as a dynamic integration of changing phenomena: knowledge, the learner, and instruction.

A static view of curriculum, however, would perceive society and the learner in more mechanistic terms. Behaviorism, for example, approaches the learner as a response system, instruction as a stimulus system, and the curriculum as planned learning outcomes defined by behavioral objectives (Tanner and Tanner, 1975: 29). It was industrialism that encouraged this notion of school as a production plant (Tanner and Tanner, 1975:30). Knowledge is compartmentalized as a consequence of this mechanistic view of the world, and this curricular fragmentation encourages a disease George Kelly called "the hardening of the categories" (Bannister and Fransella, 1975:95). Instead of a dynamic integration model, curriculum becomes a planning component separate from instruction and the learner.

**Role of the Teacher**

Role of the teacher is the second theoretical category of the Q-sort. The teacher's role as perceived by the teacher can range along the static-dynamic continuum with several bipolar constructs: ownership of knowledge as characterized by the bestower and the explorer; and, facilitation as characterized by the coach or manager. Tanner and Tanner (1975:581-591), for instance, characterize teachers as either technicians or professionals. The teacher as technician is a
philosophy that promotes "teacher proof" materials and removes the teacher from curricular decision-making; the teacher is a mechanical component in the production process of education. A "technician" would consequently fall at the static end of the continuum. The teacher as a professional is a philosophy, however, that encourages decision-making based upon the ability to conceptualize, test, and modify procedures and judgements. Such decision-making is informed and enlightened and encourages the autonomy of the teacher. A teacher who construes his or her role as "professional" would hypothetically choose items that reflect dynamism.

Common (1964) describes the technician-professional continuum in slightly different terms. The teacher is construed as an agent of policies developed by reformers, and being a consumer of reformers' products casts teachers as functionaries. According to Common, this role of agent and consumer is placed upon teachers by the policy-makers. Many teachers, however, see themselves in a different light. They see themselves as actors, defenders, and autonomous decision-makers.

Skinner (1968:249, 256-258) also seems to cast the teacher's role into a mechanical mode reminiscent of the factory metaphor. To Skinner, the teacher is one who arranges the contingencies of reinforcement, and the teacher's efficiency and productivity are improved by a technology of teaching. Skinner says of technology, "It simply permits him [the teacher] to teach more-more of a given subject, in more subjects, and to more students."
Technology is also seen as the key to shifting teaching away from being a craft (Heinich, 1984). Heinich suggests that the labor intensive nature of traditional education is inefficient and could be improved by the utilization of technology and the consequent shift in the role of the teacher. Teachers are trained to believe that instructional decisions are made spontaneously when student and teacher are interacting. To the contrary, Heinich points out the inadequacy of such an approach; "instructional technology can take over much of what teachers traditionally do" and place teachers more in a more management posture that encourages productivity and efficiency.

Of importance is whether the teacher construes him or herself as either, in Tanner and Tanner's terminology, a "technician" or as a "professional." Although most teachers may describe themselves as professionals, as well they should, do they really think and act as technicians? A teacher may have always been a "technician" because of the predisposition to construe the world as mechanistic or to have an exterior locus of control. A teacher may become a "technician" through teacher training and the influences of policy makers. As put by Tanner and Tanner (1975:591), "...the attitude of many influential educators, the large foundations, and the federal government was that excellence would be achieved despite the teacher and not because of him."

Determining the placement of a teacher's construction of instructional role on the static-dynamic continuum again may lead to understanding the extent of the perceived usefulness of dynamic computer generated graphics in that teacher's classroom.
**Instructional Media**

In the dynamism paradigm, instructional media are the communications processes which enable the storage and/or distribution of human experiences in the context of instruction (Belland, 1976). Allen (1985) describes communication that is instructional: 1) presentations are directed toward specific learning outcomes and 2) guidance is given as to how the receiver of the communication is to process the information. What is meant, however, by "the storage and/or distribution of human experiences?" Belland cites the case of print medium where the author's experiences are stored and distributed and the case of film where the experiences of the production team are those that are stored and distributed. Media thus defined become extensions of human functions and capabilities. The animated film that illustrates two chemicals reacting is the teacher's opportunity to demonstrate what is not available to the human eye and difficult to comprehend in the abstract; the computer whose programming is used to calculate prime numbers is performing a task that mathematicians do not have enough time to do by hand.

The import of the human component in communication is illustrated by a model of communication proffered by David Sless (1981). Although most models of communication encompass three basic units (sender, message, receiver), Sless chooses to illustrate communication in terms of two units: the author/message and the audience/message. Sless's contention is that "the message will not be treated as a distinct entity which can be analysed separately from author or
Audience" (p. 25). How meaning is construed and incorporated by both author and audience is central to Sless' model.

A dynamic model of instructional media likewise includes human influence, reflects human needs, and recognizes mental schema as integral components. The teacher who incorporates this view of media into his or her construct system would most likely be comfortable with the notion that media are extensions of their teaching selves; use would be considered by their assessment of teacher and student abilities and need.

For purposes of this Q Sort, the complement of media as storer and distributor of human experience will be the more mechanistic viewpoint that stems from the notion of technological determinism (DeFleur and Ball-Rokeach, 1982:184). For the technological determinist, the technological properties of the medium are the most important element of the encounter between the audience and the medium. The technology wins over the human element as the dominant influence.

If the medium is indeed the message (McLuhan, 1964), then the content becomes secondary to the medium. The implications of this are several. First of all, if influence is construed to be mainly from things technological rather than things human, then technological anxiety is likely. It does not rest well with people to feel inferior to, replaceable by, or controlled by a machine. People are uncomfortable when they assume the role of "slave to technology ... rather than the master of a fine tool" (Jay, 1981). Media, a subset of technology, becomes a threat rather than a promise.
"Technology" or "media" are not the real culprits, however. Belland and Baker (1985), in discussing technology in the future of education, say, "Discussion about technology is often especially naive since discussants voice the idea that one could have education without technology. In fact, technology has been used in education since ancient times. Technology is simply doing or thinking something using things or methods which are not part of one's own body. Thus as soon as someone used a stick to draw in the dirt, he was being technological, and when slabs of moistened earth were marked upon, dried or fired and then saved or transported for use later or in a different place, one had that special kind of technology known as a communications medium."

The issue is whether a teacher would construe state-of-the-art computer animated graphics as instructional opportunities or as a threat to instructional role, as extensions of human perspective and knowledge or as a statement of technological superiority over human capabilities.

Q Sort Items

Six (2x3) combinations of the independencies resulted as shown by Table 6. To develop a sample large enough for statistical stability and reliability, eight statements for each combination were found, making a structured sample of 6 x 6 = 36 statements in all. Although the recommended number of items is between 60 and 90 (Kerlinger, 1973:584), a smaller sample was chosen so as not to introduce fatigue or frustration as factors in the sort. The teachers did the Q sort
during breaks or at the end of a busy and exhausting day. A tired or frenzied teacher would not be able to freely think about and sort a large number of cards. Kerlinger (1973:584) cites examples of successful Q sorts with as little as 40 or 50 items. Since this Q Sort was a pilot test and exploratory in nature, the small number of items is considered a strategical advantage rather than a statistical weakness.

| TABLE 6 |

**COMBINATIONS OF INDEPENDENCIES**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>a</td>
<td>a</td>
<td>b</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>c</td>
<td>d</td>
<td>e</td>
<td>c</td>
<td>d</td>
<td>e</td>
</tr>
</tbody>
</table>

Distribution of the items is illustrated by Table 7. Although distribution is generally an arbitrary matter, determining a distribution makes the sort a forced sort. That is, the sorter is forced to place the cards in piles whose number and arrangement are specified. According to Brooks (1970:170), the number of cards in each pile is unimportant as long as there are more cards in the center piles than in the end piles so that the distribution simulates a normal curve.
The items for the Q-sort were chosen because they were identified as portraying either static or dynamic constructs. They were taken from several sources: teachers' statements, related literature, and the investigator's constructions. The majority were taken from the population of statements that the teachers had made during the interviews. These statements are either direct quotes or re-worded to provide consistency in language and clarity in meaning.

Because the teachers interviewed made many more statements of a dynamic nature than a static nature, the sample would have been biased toward dynamism unless statements from other sources were inserted. To expedite a balanced block design, another group of items were taken from literature that provided examples of the static or dynamics constructs regarding curriculum, instructional role, and media. Like the teachers' statements, the items taken from the literature are either direct quotes or have been rewritten for consistency and clarity. The source of the items that were taken from the literature have been referenced in Appendix G but were not referenced on the cards.
that the participants sorted. The reader should be cautioned that the items were lifted out of context. What may appear to be a position statement by an author may actually be the counter position used to build an argument. The reader is encouraged to check the original source to determine the actual points being developed by the authors.

The final source for items is the investigator. Some items were constructed in order to more fully develop inferences that were made by the participants or to help balance the sample of statements.

Two procedures were used to test the validity of the items before the Q Sort was administered to the teachers. Initially, an informal formative evaluation was conducted on the original set of 42 items. Graduate students with teaching experience in the public schools were used as judges. The judges were individually and separately given a set of cards to sort first according to their perceptions of which statements communicated either static or dynamic constructs. Then the judges were asked to sort the statements according to curricular, instructional, or media constructs. The reactions of a judge to the statements caused modifications in either the syntax, category assignment, or inclusion of some of the statements before the cards were given to the next judge.

Although this procedure helped to identify some misleading or miscategorized statements, a problem emerged in the manner in which the graduate students approached the task. Because the students viewed dynamism as a valuable construct, they tended to think that if they agreed with the statement, then that statement had to be dynamic. The
attempt to validate the items was confounded by the biases of the judges.

An audit procedure was then utilized to further refine and validate the Q Sort items. One measure of either the sufficiency or necessity of a categorical set is its reproducibility by an additional competent judge (Guba and Lincoln, 1983:122). The intent of the audit was to determine whether or not the statements were reasonably assigned to the two sets of categories: a) static and dynamic, and b) curriculum, instructional role, and instructional media. It is consistency in the data, rather than reliability, that Guba and Lincoln promote. The audit functions simply as a way for a judge to determine that given that perspective and those data, the same conclusions would probably have been reached (p. 124). To address competency and objectivity, a judge was selected according to at least two criteria: first, the judge's field of expertise needed to be educational technology and curriculum; second, the judge needed to be external to the dissertation committee and therefore not too familiar with the data.

After the statements were sorted by the investigator into the three function categories (curriculum, instructional role, and instructional media), the judge examined them to determine whether or not their category assignments were reasonable. The statements were re-categorized, and the same procedure was used for the static and dynamic categories. The judge's assessment of category assignments was relatively consistent with the investigator's. After some collaborative discussion, several statements were re-assigned to
different categories, some statements were reworded for clarity, and a couple of statements were eliminated because of inappropriate or redundant content.

The elimination of some statements required the elimination of other statements in order to maintain a balanced sample. In an attempt to design a Q sort that would more sensitively reflect the interviews, the additional statements consequently dropped from the sample were quotes from the literature rather than quotes from the teachers. Table 8 lists the resulting statements that comprise the Q sort.

**Administration of the Q Sort**

Prior to the administration of the Q sort, the teachers were read an explanation of the procedure, outlined in Appendix F. As in the interviews, time was an important factor, and the teachers were unanimously grateful that the procedure would take no longer than 30 minutes. Most of the teachers, however, were genuinely interested in participating in the Q sort, as though they recognized their investment in the development and outcome of the instrument. The link between the interviews and the Q sort seemed apparent to them. They further seemed to acknowledge the link between the interview and Q sort activities to teachers' professional participation in the design and implementation of innovative instructional materials.

Unlike the interviews, all the teachers had similar exposure to the Q sort with the exception of time, which was controlled by the participant and order of statements, which were shuffled before each administration. The time for each sort ranged from 15 to 30 minutes.
| 1 | About half of what I teach is the proscribed curriculum. The other half is based upon interest of and appeal to the children and myself. |
| 2 | Serving on curriculum committees gives me an opportunity to push some of the things that I want to see changed in the classroom. |
| 3 | Revolution in education will not come through technology, although it will be aided by it. It will come as we shift the role of both the teacher and the student. |
| 4 | It appears that a constant process of discovery is going on, as over and over we hear of profound new insights being carried from one art or discipline to another because an idea or phenomenon has been recorded and seen on film. |
| 5 | If students can learn best viewing a TV program then that's what I'll use. |
| 6 | I would like to be able to use media to compensate for what I can't do; an animated rotation of an object, for instance, shows multiple perspectives. |
| 7 | If my students learn well from TV it is probably because they are so familiar with the medium. It's not novel, so they can concentrate on the content. |
| 8 | I feel that we are in an age of technology where we have so many things we could use for teaching. We have got to draw upon that. |
| 9 | Some of the computer graphics I saw were obvious expressions of human creativity through technology. |
TABLE B, CONT'D

36 STATEMENTS ARRANGED IN ORDER FOR FACTORS A AND B, AND LEVELS A, B, C, D, E

(bc) 19 Curriculum is a program of activities designed so that students will attain certain educational ends or objectives.

(bc) 20 Because of the knowledge explosion, subject matter specialists should have dominant roles in curricular decision making.

(bc) 21 School activities should provide a relief from TV, radio, and cinema.

(bc) 22 Curricular decision-making is best left to curriculum supervisors and administrators.

(bc) 23 The most important things to teach are reading, math, and writing. You sandwich in the others.

(bc) 24 The school, like the industrial plant, represents a process. Raw material goes in and a product comes out. The change that occurs between input, that is the entering pupil, and the output, the departing pupil, measures the school.

(bd) 25 The teacher's guide of most textbook series is the center of my planning.

(bd) 26 Anyone can take a certain amount of common sense, mix it with their conception of important goals and create an instructional unit which has merit.

(bd) 27 Education must become more efficient.

(bd) 28 Teaching can be defined as an arrangement of contingencies of reinforcement under which behavior changes.

(bd) 29 It is important to increase the teacher's productivity—to permit him or her to teach more: more of a given subject, in more subjects, and to more students.

(bd) 30 Technologies, such as television and computer-assisted-instruction are impersonal because there is no human input.

(bd) 31 There are two kinds of people in the world: those who love machines and those whom machines are out to get. I am one of those whom machines are out to get.

(bd) 32 It doesn't matter how good the content is, kids are so brainwashed by TV that when they see the TV they think it's time to sleep or they think it's playtime. The same thing is going to happen with computers; they play video games on them, and it will be difficult for students to take computers seriously as a teaching tool.

(bd) 33 I am uncomfortable with the sophistication of some of the electronic media. The images and sounds are so good, kids will want more and more. Where will it end?

(bd) 34 Older communications media such as print are more humanizing than, say, computers are.

(bd) 35 Quite frankly, I am a little nervous about the capabilities of the newer media. They are doing too much of my job.
As a preliminary exercise to acquaint the participants with the content of the statement, the teachers were first asked to sort the statements into three categories: Agree, Neutral, and Disagree. This first sort went quickly, and the statements were generally placed evenly among the three categories.

The second sort into the forced distribution, however, posed more interesting dilemmas for the participants. Problems with the sort centered on two concerns: confusion with the meaning of some of the statements and wanting to change the skew of the distribution. Only six of the statements caused overt confusion; four of those were single incidents, one was twice identified as unclear, and one needed clarification three different times. The statement that caused the most confusion was AC1 (see Table 8). The term “educational generalist” was not identifiable by some participants. The participants also found it difficult to respond to AE16 because the statement seemed to communicate two different ideas.

The other dilemma for the participants concerned the distribution into which they were forced to place the statements versus the distribution into which they wanted to place the statements. Whereas the assigned distribution forced a normal curve, five of the eight participants wanted to skew the distribution so that more Least Agree statements could be placed at the extreme right. In fact, they seemed frustrated to have to place only one statement at the extreme point of Least Agree because they felt so strongly about a number of statements. One other participant wished for more latitude at the Most Agree end of the continuum; and, of course, that distribution would have been skewed
to the left. Finally, another participant declared a need for more latitude at both ends of the continuum. The nature of the dilemma was apparently the frustration of having to delineate only one statement as the one with which one most or least agreed.

**Data Analysis**

The data were analyzed by correlating participants and by informal analysis of the clusters of statements. An examination of the clusters of statements will be first.

**Item Analysis**

With few exceptions, items that were previously determined to reflect dynamic constructs were placed at the "Most Agree" half of the continuum, and those items that reflected static constructs were placed at the "Least Agree" half of the distribution. In order to determine those statements that were most meaningful to the teachers, a table was constructed that isolated the more strongly placed items. The exceptions to the rule, however, are those few statements that were determined a priori to be "dynamic" in nature but placed in the "Least Agree" columns by teachers whose other responses seemed to reflect a dynamic viewpoint. At the same time, an otherwise dynamically oriented teacher would place "static" statements in the "Most Agree" columns. The nature of these statements are also examined.

In Table 9 are listed the statements that were placed in the top third of the continuum that reflects those statements with which teachers said they most agree. The items are ranked by the frequency
TABLE 9

"MOST AGREE" ITEMS RANKED BY FREQUENCY OF RESPONSE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>F</th>
<th>̅X</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ad) I try to use a variety of instructional materials so as to reach all the different learning styles of my students.</td>
<td>8</td>
<td>8</td>
<td>7.13</td>
</tr>
<tr>
<td>(ac) Things happen in the classroom, outside of the planned curriculum, that provide instructional opportunities too good to pass up.</td>
<td>4</td>
<td>6</td>
<td>5.88</td>
</tr>
<tr>
<td>(ad) Serving on curriculum committees gives me an opportunity to push some of the things that I want to see changed in the classroom.</td>
<td>11</td>
<td>5</td>
<td>5.88</td>
</tr>
<tr>
<td>(ae) I would like to be able to use media to compensate for what I can’t do; an animated rotation of an object, for instance, shows multiple perspectives.</td>
<td>15</td>
<td>5</td>
<td>5.25</td>
</tr>
<tr>
<td>(ac) When I plan my lessons, math and language arts as well as science or even health may be integrated.</td>
<td>6</td>
<td>4</td>
<td>5.88</td>
</tr>
<tr>
<td>(ac) I try to stay within limits of the curriculum but stretch the meaning of what’s in the curriculum in order to motivate kids.</td>
<td>3</td>
<td>4</td>
<td>5.50</td>
</tr>
<tr>
<td>(ac) I believe mathematics exists outside the classroom.</td>
<td>2</td>
<td>4</td>
<td>5.50</td>
</tr>
<tr>
<td>(ac) I think we’re too much into getting kids to learn facts. I think we need to emphasize process...how to use a microscope, how to find things out, how to ask questions.</td>
<td>5</td>
<td>4</td>
<td>5.50</td>
</tr>
<tr>
<td>(ae) If students can learn best viewing a TV program then that’s what I’ll use.</td>
<td>14</td>
<td>4</td>
<td>5.25</td>
</tr>
</tbody>
</table>
by which an item was placed in the upper third of the response continuum. The mean response is given to indicate the relative position of the item on the nine point scale (8 to 0), and the standard deviation is given to indicate the consistency of response.

The strongest item at the "Most Agree" end of the continuum was ad8: "I try to use a variety of instructional materials so as to reach all the different learning styles of my students." This item reflects its strength in several ways. First of all, the item appears in every sort in the Most Agree end of the continuum. Secondly, if the frequency of responses is limited to the first two columns, ad8 is still strong at 7 counts. Third, the standard deviation is very low and indicates consistency of response. Ad8, because it places strongly in relation to the other items, appears to communicate an attitude and a goal that are important to the teachers; the teachers seem to be sensitive to the various ways in which their students learn, and they want to be able to attend to those differences with a variety of instructional materials.

The desire for a variety of media could have both proactive and reactive meaning. Their role is seen in part as being responsible for the purposeful individualization of instruction; a strategy that requires planning. Also, as indicated by interview comments, teachers hope that the use of a variety of materials will somehow reach most of the students. The use is random, and the effect is hoped-for, not planned for; the effect may be serendipitous individualization. Whether the dominant role is purposeful individualization of
instruction or an umbrella effect of variety is not strongly reflected in this set of data.

At the same time, the teachers seemed to be sensitive to instructional opportunities that may lie outside planned events, as indicated by the strong response to ac4: "Things happen in the classroom, outside of the planned curriculum, that provide instructional opportunities too good to pass up." Contrary to Heinich (1984) who pans the "teachable moment", the teachers see their roles as more expansive than just delivering the proscribed curriculum, and they see the curriculum as a beginning and not an end to the purpose of education.

A third item to be highlighted is ael5: "I would like to be able to use media to compensate for what I can't do; an animated rotation of an object, for instance, shows multiple perspective." The teachers clearly see media as extensions of their teaching selves and appreciate the opportunity to illustrate a concept or phenomenon that otherwise would not be available.

Finally, serving on curriculum committees is seen as a productive activity (aell). Experience, however, shaped this opinion. Seven of the eight teachers had served, or were serving, on curriculum committees.

The other items in Table 9 are not as strong in response as the first four, but since they are placed in the "Most Agree" columns at least half the time, they are considered worthy of inclusion. Ael4, for instance, reiterates the importance of media as tools for instruction and the acceptance of the appeal a particular medium may
have for students. The integration of curriculum within and outside the classroom is reflected by items by ac6 and ac2. All four placements of ac6, by the way, were in the first two columns, indicating strong feelings toward the statement. Ac2, however, is suspicious as a meaningful statement. Several of the teachers outwardly indicated the statement was so obvious that one had to agree with it but wished it was not there so as to make room for more meaningful statements. Although the importance and flexibility of the curriculum is supported by the statement ac3, the nature of the curricular content is seen by the teachers as necessarily responsive to students' motivational and instructional needs as well as, presently, too restricted to the learning of facts. The teachers see the students needing more exposure to process and problem solving. Again, the teachers seem to reflect the notion that their instructional role and the purpose of the curriculum is not only to be accountable for discrete units of information to be mastered by their students but to be responsible for the wide range of student skills and attitudes that will provide lifelong tools for examining and understanding phenomena.

The items that fell into the "Least Agree" portion of the sort, as illustrated by Table 10, were stronger in response. The means of the most frequently placed items ranged from 1.13 to 2.25 in columns that scored 0 to 2 whereas the "Most Agree" items ranged from 7.13 to 5.25 in columns that scored 8 to 6. The means of the "Least Agree" items indicate that the teachers felt more strongly against some items than for some items.
TABLE 10

"LEAST AGREE" ITEMS RANKED BY FREQUENCY OF RESPONSE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>F</th>
<th>( \bar{X} )</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>(bc)</td>
<td>22</td>
<td>7</td>
<td>1.13</td>
</tr>
<tr>
<td>Curricular decision-making is best left to curriculum supervisors and administrators.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(be)</td>
<td>36</td>
<td>6</td>
<td>1.50</td>
</tr>
<tr>
<td>Quite frankly, I am a little nervous about the capabilities of the newer media. They are doing too much of my job.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(bd)</td>
<td>28</td>
<td>5</td>
<td>2.25</td>
</tr>
<tr>
<td>I think a lot of materials need to be almost &quot;guarded.&quot; When other teachers have used &quot;my&quot; materials, students are not as interested when they encounter those same materials in my class.</td>
<td></td>
<td></td>
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<tr>
<td>(be)</td>
<td>34</td>
<td>5</td>
<td>2.25</td>
</tr>
<tr>
<td>I am uncomfortable with the sophistication of some of the electronic media. The images and sounds are so good, kids will want more and more. Where will it end?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(be)</td>
<td>31</td>
<td>5</td>
<td>2.50</td>
</tr>
<tr>
<td>Technologies, such as television and computer-assisted-instruction are impersonal because there is no human input.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(be)</td>
<td>32</td>
<td>4</td>
<td>2.00</td>
</tr>
<tr>
<td>There are two kinds of people in the world: those who love machines and those whom machines are out to get. I am one of those whom machines are out to get.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(bc)</td>
<td>24</td>
<td>4</td>
<td>2.25</td>
</tr>
<tr>
<td>The school, like the industrial plant, represents a process. Raw material goes in and a product comes out. The change that occurs between input, that is the entering pupil, and the output, the departing pupil, measures the school.</td>
<td></td>
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</tbody>
</table>
The strongest reaction by the teachers was to item bc22:
"Curricular decision-making is best left to curriculum supervisors and
administrators." The teachers apparently feel strongly about the
contribution that they can, and should, make to the development of the
curriculum that they are asked to teach.

The next strongest response was elicited by be36: "Quite frankly,
I am a little nervous about the capabilities of the newer media. They
are doing too much of my job." As indicated by the interviews and the
reactions of the teachers to the instructional possibilities of the
computer generated graphics, innovative instructional media provide
opportunities rather than threats. The teachers in this sample, at
least, are secure in the role instructional media has in their
professional endeavors.

The next four items (bd28, be34, be31, be32) all continue to speak
to the inter-relationship media and instructional role of the teacher.
Not only are the uses of instructional materials pliable enough to be
shared among teachers and remain interesting to students, but the newer
technologies in which those materials are packaged or by which they are
delivered are seen as useful, friendly tools.

Finally, at least half the teachers strongly reject the notion of
school as factory where students are the input and their performance
the output. As seen by their "Most Agree" responses, the teachers view
the educational process as one that is responsive to the student, to
the world of knowledge, and to the needs of the society it serves.

The categories assigned to the items, however, were arbitrary
until the sort yielded categories that were more meaningful to the
realities of the teachers themselves. An examination of the total group of strongest responses provided three areas of concern that are closely related to the original independent levels of the Q sort: (1) the importance of instructional media, (2) an opportunity view of curriculum, and (3) a position statement about the role of the teacher.

Instructional media emerged as an important issue to the teachers. Not only did they ascertain the opportunities for individualizing that media has to offer, but they firmly rejected any notion that media was a threat and therefore to be regarded with suspicion or as competition. Media is clearly viewed by these teachers as an extension of their teaching selves and as an instructional tool through which human experience comes.

Secondly, the teachers reflected through their responses an opportunity view of curriculum as outlined by Belland (1976). In the opportunity model of curriculum, learning opportunities for the learner come from both planned and unplanned sources. An array of instructional activities are built from community resources, instructional materials, building facilities and so forth, all of which are seen to "provide necessary learnings for effective adult functioning in society" (p. 328). The teachers in this study are clear in their intent to follow the proscribed curriculum but reserve the right to acknowledge and integrate instructional opportunities. A rich array of instructional materials and media is one way, as identified by the teachers, to accomplish this enriching of the curriculum.

The teachers' insistence upon their role in playing a major role in the development of the curriculum, planned or unplanned, is part of
their position statement on the role of the teacher. These teachers see themselves clearly as wanting to be professionals, not consumers of policy handed down from administrators above or from those outside. Concurring with Commons's (1984) analysis, the teachers want to be actors, defenders, and autonomous decision-makers. Responsibility to the student is further illustrated by the teachers' sensitivity to the students' individual needs, the importance of acknowledging non-judgmentally what motivates students, and the notion of students as humans rather than products.

As previously described, however, there were some statement placements that seemed inconsistent with the patterns of response. Considering the overwhelming pattern of agreement with the "dynamic" statements and disagreement with the "static" statements, the five statements that were frequent exceptions to the pattern are worthy of further examination. These statements are listed in Table 11.

Ac1 can be dismissed because of the confusion it caused the participants. The teachers invariably asked what this statement meant, and would occasionally voice the opinion that the statement sounded all inclusive. They were not reacting to the holistic view that a generalist would provide but rather they were reacting to the notion that no else but an educational generalist would be determining curriculum.

Ac9 is a puzzle because the statement was meant to reflect the dynamic notion that knowledge isn't a commodity to be "handed over". Either the statement didn't adequately communicate the construct, or, the respondents do believe in ownership of knowledge that a teacher
imparts. This would not be inconsistent with what is taught in many teacher preparation classes.

**TABLE 11**

**INCONSISTENTLY PLACED STATEMENTS**

<table>
<thead>
<tr>
<th>(ac)</th>
<th>1</th>
<th>(bc)</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because of the knowledge explosion, educational generalists should have greatest input into curricular decision-making.</td>
<td></td>
<td>Curriculum is a program of activities designed so that students will attain certain educational ends or objectives.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(ac)</th>
<th>9</th>
<th>(bc)</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learners construct their own meaning from my teaching. I can't give understanding directly to my students.</td>
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<td>Education must become more efficient.</td>
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</table>

<table>
<thead>
<tr>
<th>(bc)</th>
<th>30</th>
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<tbody>
<tr>
<td>It is important to increase the teacher's productivity - to permit him or her to teach more: more of a given subject, in more subjects, and to more students.</td>
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</tbody>
</table>

Bc19 is a common definition of curriculum that doesn't sufficiently explain the multiple sources, activities, or ends of curricular development (Tanner & Tanner, 1975:43). The statement, on second examination, looks very innocuous and perhaps most educators would not question its content without some prodding and discussion. Since this statement was placed in the middle columns by other respondents, it didn't communicate very strongly. Bc19 should be rewritten to more adequately communicate a narrow definition of curriculum.
Given the daily demands on teachers, it should be no surprise that bc27 and bc30 would be placed in the "Most Agree" columns.

Although the intent of the items was to reflect the factory model of education, a notion that was rejected in the form of the statement bc24 (e.g. The school is like an industrial plant...), it apparently spoke to the teachers' need to get more done in less time. One only need to recall an interview comment in which one teacher said that her only problem with the current curriculum was the lack of time to deliver it.

**Correlations of Participants**

In addition to examining the data across items, the data can also be analyzed across subjects. An 8 x 8 correlation coefficient analysis was performed on the data. Table 12 provides the correlation coefficients for the eight participants.

The correlations between subjects were generally high. In addition, significance of the correlations didn't fall below .01 until the correlation factors dropped to .34. The high correlations were, to a large measure, due to the strong split between the dynamic statements and static statements. Three participants, however, showed strong correlations with each other but weak correlations with the rest. These participants (2, 3, and 6) had, in comparison, many more static items in the Most Agree columns (and vice versa) than the other participants. They seemed more concerned with the proscribed curriculum, for instance, as indicated by their agreement with bc23: "The most important things to teach are reading, math, and writing."
You sandwich in the others." They were the only ones to agree with that statement.

**TABLE 12**

CORRELATION COEFFICIENTS FOR 8 TEACHERS

*(n = 36 statements)*

<table>
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<th>8</th>
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<tr>
<td>1</td>
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<td>.49</td>
<td>.62</td>
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<td>.....</td>
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<td>.40</td>
<td>.43</td>
<td>.60</td>
<td>.46</td>
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<td>.70</td>
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<td>.53</td>
<td>.71</td>
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<td>5</td>
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<td>.47</td>
<td>.71</td>
<td>.76</td>
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<td>6</td>
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<td>.58</td>
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</table>

Participant 3, in particular, was much more concerned with the use and effects of media. She didn't necessarily want media as a compensation for what she couldn't do, she felt that the television
medium interfered with the content, and she didn't recognize computer
graphics or computer assisted instruction as expressions of human
creativity or knowledge. Judging by the placement of items, she also
reflected a teaching role more constrained by the proscribed curriculum
yet the number one statement she agreed with was ac4: "Things happen
in the classroom...that provide instructional opportunities too good to
pass up." Perhaps her responses describe a basic conflict of classroom
teachers: the need to deliver the curriculum while still preserving
the instinctual recognition of the teachable moment.

P2 and P6, however, were accepting of instructional media. P2
placed greater emphasis upon the importance of the subject matter
specialist in determining curriculum. Her viewpoints are significantly
molded by the current experience with her daughter’s education. The
earlier interview revealed her interest in her young daughter’s mastery
of the basics of reading and writing.

The strong patterns of response in the agreement with the
"dynamic" statements indicates a bias toward holistic, inter-related
notions of curriculum and instruction as well as an attitude towards
media as channels of human communication and as extensions of their
teaching selves. The accepted statements that connote productivity and
efficiency may not necessarily be reflections of static notions of
education but a reflection of the teachers’ reality. The statement
"only teachers know teaching" describes well the conflict teachers have
between being accountable for teaching those skills that are publicly
deemed necessary for productive adult life and yet feeling the
responsibility for being sensitive to individual needs and the teachable moment.

Summary

Out of the interview data emerged three categories of teacher concerns: instructional role of the teacher, the function of instructional media, and sources of curriculum. How these three categories interacted with the computer graphics centered upon the construct "dynamic systems." Dynamic systems, systems that portray the active reciprocity and inter-relationship of their elements, are easily, and uniquely, modeled with computer generated animation and are also the type of phenomena that the interviewed teachers find valuable, but difficult, to demonstrate and illustrate. The Q Sort became a way of seeing how and to what extent instructional role, instructional media, and curriculum paralleled what appeared to be the teachers' interest in dynamism. The Q Sort data is summarized as follows:

1. The teachers participating in the Q Sort placed most statements that described dynamic phenomena towards the "Most Agree" end of the continuum and placed most statements that described static phenomena toward the "Least Agree" end of the continuum.

2. The correlations among the teachers were very strong for five of the participants. The three who had weak correlations with the others did, however, correlate more strongly with each other. These three tended to put more "static" statements toward "Most Agree" than did the others. The statement that only these three agreed upon concerned the proscribed curriculum. This statement read, "The most
important things to teach are reading, math, and writing. You sandwich in the others." Two of the three teachers who agreed with this statement are elementary teachers.

3. The item placed most consistently at the extreme end of "Most Agree" concerned teachers' willingness and attempt to utilize a variety of instructional materials in order to address the variety of student learning styles in their classrooms (see Table 9).

4. The item placed most consistently at the extreme end of "Least Agree" said that curricular decision-making should be left to those other than teachers (see Table 10).

5. The placement of statements fell into three clusters: the importance of instructional media, an opportunity view of curriculum, and a position statement about the role of the teacher. The teachers value and utilize a variety of instructional media, they see curriculum arising from sources other than the proscribed curriculum, and they want to be acknowledged as the professionals that their training, experience, and expertise warrant them to be.

As hypothesized, this group of teachers that recognized and valued the power of state of the art computer generated graphics to model dynamic phenomena also strongly valued dynamic models of education.
CHAPTER VI
SUMMARY AND IMPLICATIONS

Although the use of high resolution computer generated animation is widespread in advertising and entertainment, there is little evidence that these types of electronic images are useful, or even desired, for instructional purposes. Persons in the computer graphics industry are cognizant of the fascination that computer generated animation holds for its audiences, but there is no information to help understand the forces behind such attention-gaining characteristics. The utility of these images, however, are not limited to the selling of products. The power of the picture to gain attention and to communicate has been well documented, and the power of the computer generated animated images is thought to be as useful, or even more useful, to instructional communication.

The source for design and implementation, however, usually comes from anyone other than the persons who will be asked to utilize the materials. Researchers, designers, and curriculum specialists, for instance, frequently determine the content and manner of delivery of instructional materials. The classroom teacher becomes the agent for the dissemination of the innovation. The classroom teacher is not necessarily an agent, though, but an autonomous decision-maker. It is the classroom teacher who decides whether or not an instructional
procedure, policy, or curricular content is incorporated or abandoned. The autonomous nature of the teacher's role, plus recognition of the teacher's expertise, require that designers acknowledge and utilize teachers as a legitimate source for the design and implementation of instructional materials.

Summary

The purpose of this study was to provide a forum in which teachers could view, react to, and provide instructional uses for state of the art computer generated graphics. The results are intended not only to be used in the design of instructional computer generated animation but also to provide insight into the curricular impact these images may have, the problems of dissemination and utilization, and the identification of appropriate research questions and methodology.

The study was designed to be conducted in four stages. The first stage consisted of two sets of individual semi-structured interviews during which video tapes of computer animation were shown to each participant. A period of data analysis after the first set of interviews was used to prepare for the second set of interviews. The second stage consisted of a data analysis of the two interview sessions during which a Q sort was prepared. The Q sort, intended as a triangulation of the interview data, was administered as the third stage. This was followed by data analysis and interpretation, the fourth stage.

The sample for this study was drawn from the population of practicing teachers in Groveport Madison Local Schools, Franklin
County, Ohio. The participants were eight classroom teachers of elementary and junior high grades. These teachers were identified by peers and administrators as being perceptive, creative teachers. The intent was not to choose the best teachers but to be able to access the ideas and notions of a group of teachers who were respected for their opinions and praised for the quality of their work.

**A Priori Questions**

The research questions outlined in Chapter III guided, but did not limit, the investigation. The answers to the questions that were constructed a priori are discussed in relation to the issues that emerged during the data collection and analysis. Some of the questions are grouped for response because of their inter-relatedness.

**QUESTION 1: How do teachers' selection of instructional materials affect perceptions of the utility of computer generated graphics?**

Accessibility and student appeal were major factors in the teachers' selection of instructional media. The attempt to gain the attention of their students and provide motivation for learning was a top priority of the teachers. The attraction of a medium, however, would not be enough impetus for use if the medium were not easily accessible.

Three of the five media appropriate for the delivery of computer generated animation fit the criteria for use: television, videocassette recorder, and the film projector. Frequent use of these media indicate that the manner of delivery of computer generated animation would not interfere, and would probably enhance, adoption of instructional
computer animation by the teachers. The two other media appropriate for the delivery of computer animation, computers and videodisc players, were not used frequently by the teachers because these media were either recently implemented as in the case of computers or else, like the videodisc players, not available.

QUESTIONS 2 & 3: What formal features of the medium are identified by the teachers? Which of those formal features were determined by the teachers to be useful for instruction?

The formal features that the teachers consistently identified were color, sound effects, complexity, and movement. The range and arrangement of colors in the animations held a great deal of appeal for the teachers. Not only did they personally like the colorful images, but they felt that their students would attend to the colorful and well-designed pictures. The music, in addition, was well received and thought to enhance the images. The assessment of the visual complexity depended upon a teacher’s grade level. Teachers of younger children thought the highly complex designs and movement of the commercial animations would be perceptually confusing and instructionally detrimental whereas the teachers of the older children thought the complexity was a definite attribute for gaining attention. The speed of the movement in the animations was liked or not, again, depending upon the grade level of the teachers’ classes. The direction of movement, however, was generally thought to be unique and instructionally useful regardless of the age of the student. The movement along the depth axis (the z axis) was considered to be
especially useful to young children because of the need to help children learn spatial orientation.

**QUESTION 4: What new content is identified for inclusion in the curriculum after seeing the graphics?**

An allegiance to the current curriculum and lack of training in curriculum development and instructional design substantially inhibited the teachers' ability to identify new curricular content. The teachers interviewed for this study were generally satisfied with the current curriculum; most of them had, after all, served on committees that formulated the curriculum they were delivering. These teachers consequently viewed and analyzed the computer graphics as ways to better package and deliver the current curriculum. Secondly, the teachers' lack of substantive training in curriculum development and instructional design principles made it difficult for them to extrapolate beyond their immediate concerns of day-to-day classroom instruction. The practicality ethic in the teachers influenced their perceptions of the utility of the computer graphics. Although the teachers liked the form of the graphics, they generally saw in them new ways to teach the current content.

**QUESTION 5: What is the nature of the newly included content?**

Even though no new content for the curriculum was identified, the nature of the suggested instructional uses of the graphics, however, is especially revealing of the contributions this technology can make to education. The teachers' recognition of the dynamic models of teaching and learning that the computer graphics allow was a major outcome of the interviews. The teachers continually characterized the graphics as
an effective means of demonstrating dynamic systems, i.e. cause and effect, concurrent operations, and the relationship of a part to its whole. Their recognition of the graphics' ability to activate higher cognitive processing and their eagerness to utilize such materials indicate that higher cognitive processing is valued as a meaningful instructional activity. The teachers saw in the animated images ways to present phenomena that had heretofore been unattainable, with current instructional media, for many students.

QUESTION 6: What teacher variables such as experience, grade level taught, etc. interact with emerging constructs regarding use of these graphics?

The two predictors of the teachers' reactions to the graphics were grade level taught and subject expertise. Grade level differences brought forth concerns with the form of the graphics, i.e. complexity and speed of movement were considered to be beneficial attention-getting properties for middle schoolers but were considered to be distracting and confusing to younger children. Subject expertise interacting with grade level obviously influenced reactions to the content of the graphics. For instance, the middle school science teachers were naturally more attracted to the medical demonstration tape, and the elementary language arts teachers were quite attracted to "Snoot and Muttly" as a language development activity. On the other hand, "Snoot and Muttly" was considered "cute" by the middle school teachers, as a rule, but did not have any educational value for their curricula.
The Q Sort

There was much more to the source of the teachers' reactions than what the teachers' demographic or interview data could reveal. The Q Sort, intended as a triangulation of the interview data, became an extension of Question 6 and provided insight into more fundamental issues such as the teachers' philosophical orientation and how that orientation would affect reaction to and adoption of computer generated animation as a useful instructional tool.

Two philosophical orientations of the teachers, static and dynamic, were examined by the Q Sort in relation to three categories of educational concern that emerged from the interview data: sources of curriculum, instructional role of the teacher, and the role of instructional media. The results of the Q Sort follow.

Five broad questions that were addressed are outlined below, and their explications follow.

QUESTION 1: Does a teacher who recognises and appreciates the dynamic properties of state of the art computer generated animation also view education as a dynamic system?

As was expected, the teachers placed most of the statements that connoted "dynamic" notions toward the "Most Agree" end of the continuum. Whereas the interview data revealed the teachers' appreciation of the manner in which the computer graphics could model dynamic phenomena, the teachers agreed with statements that portrayed education as a dynamic system.
QUESTION 2: Will the propensity towards static or dynamic notions be consistent across all three categories of teacher concerns (instructional role, instructional media, and curriculum)?

In general, the teachers agreed with statements that described instructional role of the teacher as autonomous professionals and also with statements that described instructional media as extensions of their teaching selves. The exception to the overwhelming agreement to "dynamic" statements, however, were some statements out of the curriculum category. Several statements regarding efficiency and productivity, terms associated with a static or mechanistic view, were placed in the "Most Agree" end of the continuum. These responses were consistent, however, with interview statements of teachers who were generally satisfied with the content of the curriculum but were frustrated by the lack of time to deliver it.

QUESTION 3: How would a teacher who fundamentally views education as a static system construe the usefulness of a medium that succinctly models dynamic phenomena?

Because the sample of teachers showed a strong bias for dynamic views of education as modeled by this Q Sort, this question cannot be sufficiently addressed with the data from this study but could certainly be investigated with a study that utilized stratified sampling, that is, sampling that covers several teacher attributes or categories.

QUESTION 4: How will teachers order instructional role, instructional media, and curriculum on a static-dynamic continuum?
Statements regarding the three categories were generally mixed throughout the continuum. No significant patterns of category ordering was found.

**QUESTION 5:** What superordinate concerns of the teachers does the clustering of statements reveal?

The clustering of statements provides three superordinate constructs: 1) the importance of instructional media, 2) an opportunity view of curriculum, and 3) a position statement about the role of the teacher. The teachers who participated in the Q sort use media because it helps them do their job efficiently and creatively. Secondly, although they feel a responsibility to deliver the proscribed curriculum, these teachers recognize that curriculum can arise from unplanned sources also. The freedom to integrate instructional opportunities is very important. Third, the teachers state very clearly that they do not want to be agents of a system but want instead to be able to provide the input that their experience and expertise has to offer to curriculum development.

**Implications**

The utilization of high resolution three dimensional computer generated animation for instruction is more and more probable as production and hardware costs drop. To avoid naive or ill-conceived use of these graphics in the classroom, the rationale and design of such use should be grounded in theory and practice. There is very little research regarding the instructional effectiveness of even traditional animation; and because computer generated animation has
been used almost exclusively for commercials and entertainment, there is almost no research on the instructional usefulness of computer animation.

Implicit in this study is the recognition of the need to approach the instructional applications of an innovative medium proactively so that the eventual utilization is immediately effective and that the painful adaption of new materials to classroom realities is avoided. The purpose of this study was to use teachers to identify instructional uses of computer generated animation, examine problems of utilization, and curricular impact. In addition, another purpose of the study was to identify research questions, and appropriate research methodologies, in order to lay a foundation upon which to base implementation into the classroom.

The results of the study have several major implications regarding the design of computer generated animation for instruction, utilization, teacher education, and curriculum development. These implications are described below in relation to the questions posed by the study.

**Designing Computer Generated Animation for Instruction**

*What formal features of the medium did the teachers identify as particularly helpful or detrimental to instruction?*

Since people do absorb visual information more easily than verbal information (Gibson, 1979:261-2; O'Shea, 1983:1), computer animated graphics is rapidly being recognized as a powerful communication tool. The teachers in the study, however, were not about to engage in wholesale adoption of computer graphics for instruction. Two issues
regarding the educational use of computer animation reflect the teachers' cautious assessment of the medium: the cognitive effects of visual stimulation and learning, and the overuse of attentional graphics.

Attentional illustrations, as described by Duchastel (1978), have motivational and attention-gaining purposes. Sless (1981:107-110), however, points out that it is difficult to differentiate between the exceptional and the slick in attentional pictures, and attentional illustrations that are "slick" use hidden influence resulting in covert or incidental learning vis-à-vis advertising. The teachers interviewed for this study, for instance, would sometimes point out the educational inappropriateness of the form that some of the commercials had. Sless explains that these types of images "...blunt sensibility by their sheer quantity and repetitiveness" (p.109) and discourages development of useful, cognitive schemata in the viewer. Educators are encouraged by Sless to avoid this covert style of media usage. Sless, however, doesn't discourage creative design; he says there is room for "magic", but it should be less "furtive" (p. 109).

That "magic" can be created for educational use without being furtive is illustrated by the commercial and educational success of "Sesame Street", produced by Children's Television Workshop. "Sesame Street" was the first to apply the techniques of commercial television to instruction (Fowles, 1978). The teachers in the study also recognized the need for incorporating aesthetically pleasing design in instructional materials and would cite "Sesame Street" as an example of
It is the development of the cognitive schemata of the viewer that separates slick from excellent or intellectual reduction from intellectual enhancement. Attentional pictures may motivate but learning occurs from pictures that cause cognitive processing to occur. They are pictures that not only gain attention, but stimulate recall of familiar schema, make new information salient, and stimulate assimilation and accommodation of the new information. To totally supplant these cognitive processes, as does much of commercial advertising and entertainment television, is to reduce the level of intellectual literacy of the viewer.

Just as it would be detrimental to saturate instructional animations with slick attentional visual effects, it would also be detrimental to intellectual development to saturate instructional animations with the modeling of cognitive processes, a recognized attribute of computer animation. A sensitivity to the degree of supplantation required by, or beneficial to, the learner is necessary in order to utilize the power and appeal of computer generated animation in beneficial ways.

One of the criticisms of learning via television, film, and other visual media has been the detrimental effect upon literacy. Heavy television viewing has a negative effect upon the viewers' writing, language, and thinking skills (Adams and Fuchs, 1986), an observation with which most teachers would agree. Intellectual or linguistic complexity is avoided in order to reach the largest audience. Reading, on the other hand, has always been recognized as the developer of the intellect. Eco (1981:), as cited by Suhor (1984),
says that reading imaginative writing is a "...joint venture in which the reader cooperates with the author in the process of making meaning." Cannot imaginatively designed graphics also involve the viewer and the designer in collaborative effort? Teachers need evidence that such graphics can, and do, exist.

Utilization

How will the manner of delivery affect the use of computer animation?

If computer animations are not seen to be instructionally useful by the teachers or accessible to the teachers, they will not be used, no matter how well produced they are. In addition, materials must maintain a certain amount of ambiguity in order to allow the teacher to adapt them to the everchanging climate of the classroom and needs of the students. The materials must also be perceived as compatible with the teacher's teaching style. The appeal that computer animation on videotape would have for classroom teachers is the flexibility of use and the availability of videocassette recorders (VCR's). The growth rate for the number of schools using VCR's is higher than the growth rate for microcomputers (Reider, 1985). Videocassette recorders and videotapes are inexpensive, accessible and easy to use.

How will educational philosophies of both the designer and the teacher affect utilization?

The nature of utilization is a different matter. Will designers and teachers perceive computer animation be the filmsstrip or blackboard of the future (Franz Frederick, personal communication, February 13,
1986)? Or both? If one construes filmstrips to be representative of self-contained instructional packages that become obsolete as knowledge changes, then the answer is "perhaps." If the blackboard is construed as an instructional environment that allows for student and teacher interaction, for the documentation of developing ideas, then the answer is also "perhaps." The use of an instructional medium is largely dependent upon the capabilities of the technology, the intent of the instructional designer, and how teachers construe their role in the classroom and the function of instructional media. If computer animation is designed to be incorporated into teacher-proof packages or the teacher construes video to be an adjunct to instruction rather than an integral part of the teaching-learning process, then, yes, computer animation could become the filmstrip of the future. But two developments could encourage computer animation to become the blackboard of the future: (1) sophisticated technology that allows student-teacher interaction with high resolution computer animation, and (2) teachers, such as those interviewed, who value higher cognitive processing and who like to use the kinds of media that provide that kind of learning.

**Teacher Education**

*What skills do teachers need in order to meaningfully implement computer animation or other new technologies?*

With or without the interactive capabilities, computer generated animation can be the blackboard of the future, as most new media can be, if teachers are given sufficient pre-service and inservice training.
in the theories of instructional media and curriculum. Teacher education programs are increasingly stressing how to teach rather than why certain things are taught (Apple, 1983). As developing technology increases opportunities to control visual phenomena over time and space, teachers need to be able to critically assess the appropriate manipulation of temporal and spatial elements. The teachers in this study were enthusiastic and creative teachers but, with the exception of one, were generally naive about the use of iconic visuals in instruction. Most teachers evaluated the graphics at an intuitive level.

Critical skills, however, demand knowing why things are done. Take, for instance, the static or dynamic representation of a concept. When is it appropriate to hold something apart and still for examination, and when is it more appropriate to model its processes or rotate it? Although the design of appropriate instructional activities for sophisticated media are mostly made in the production stage by professional designers, teachers still do the selecting. On what bases will teachers make the selections, or requests, of computer animation for instruction?

Understanding the human impact upon technology is another responsibility of teacher education that can affect sensitive utilization of instructional media. If media are perceived as a ways to store and/or distribute human experience (Belland, 1976), then teachers would realize that media effects are determined by the intent of the producer/writer, the learning environment in which it is used,
and the student who uses it. With an understanding of the teacher/tool dynamics, the teacher can make thoughtful selections of media.

At the same time, the teacher who is educated about curriculum sources, possibilities, and influences is even more able to make appropriate choices of media for instruction. Ben-Peretz and Katz (1980) say succinctly, "Teachers who are able to differentiate between various aspects of curriculum materials, who are well practiced in thinking about curriculum potential, may be better equipped to make professional decisions about the way materials could be used in diverse educational situations." The computer animation of a beating heart, for instance, may be perceived by a sensitive teacher as not only appropriate for health class but as material that may also be effectively used to discuss "system", "cause and effect", and "networking."

Curriculum Development

How can computer generated animation affect the content of curriculum?

The curriculum, according to Apple (1983), needs to be both conservative and critical by preserving ideals or by questioning if those ideals are not being met. As described by the teachers, computer animation could positively affect the nature of the curriculum, as already discussed, by making available more models of dynamic phenomena that are seen to be lacking in curricula.

There is a hidden curriculum, however, in the form of the visual media that students encounter outside of the classroom (Sless, 1981:90,
This sample of teachers, for instance, were very aware of the influence of television, rock video, and film. The education of vision, asserts Sless, is not under the direct influence of the schools; educators are neglecting to teach critical TV viewing skills (Adams and Fuchs, 1986) and the basics of aesthetics. The definition of literacy, for instance, should be broadened to include aesthetic literacy, as well as social, political and technological literacy (Apple, 1983).

State of the art computer generated animation can provide aesthetic experiences for students. Can the pragmatic nature of public education, however, make room for expressive content in an instrumental curriculum? Of the sixteen teachers who viewed the animations during the pilot and the main study, only one, a bystander, commented on the value of exposing children to fascinating and creative art that those images seemed to be. Although the teachers that were interviewed agreed that instructional design should be aesthetically pleasing, the aesthetic traditions that these teachers seem to feel comfortable with are pragmatic and mimetic traditions, i.e. art serving to inform or to replicate what is seen. How long will schools resist acknowledging the impact of visual media? Can the hidden curriculum of which Sless speaks be made explicit in formal curricula?

Research Topics and Methodologies

Because this was an exploratory inquiry into instructional uses of state of the art computer generated animation, more questions were
generated than answers given. The following are recommendations for further research.

1. Researchers and instructional designers should continue to consult with classroom teachers in the study and design of instructional materials that these teachers are being asked to implement. In addition to their professional training, teachers have a special kind of expertise that comes from daily interaction with students. Furthermore, teachers appear to want involvement in the design of instructional materials they will be using; they have had too many frustrating experiences with inadequately and insensitively designed materials.

2. A proactive approach to the study of innovative instructional technology is recommended whenever possible. Background research before a new technology becomes entrenched in use takes advantage of a "window of opportunity." This window allows the investigation of a setting and its participants before, during, and after implementation.

3. In order to continue inquiry into instructional uses and utilization of computer animation, this study should be expanded to include a larger, more stratified sample. A larger sampling would provide more insight into the acceptance and type of utilization the graphics may have across a larger population. Levels of the stratified sample could include sex, grade level, subject expertise, and teaching philosophy.

4. If refined, the Q Sort could provide preservice and inservice teachers insight into their teaching styles and educational philosophies. The items require validating through repeated
administrations to different populations of teachers. Of special importance to the validation of the dynamic and static constructs is the need to administer the Q Sort to teachers who have been previously identified as holding more static notions of education.

5. The Q Sort could also be strengthened by a different manner of administration. Having each subject sort twice, under different postures such as "The way things really are" and "The way things could be in the best of all worlds" could provide greater understanding of his or her construct system.

6. Utilizing holistic as well as experimental research paradigms provides a complementarity of methods that is useful for the study of complex, contextually rich phenomena, i.e. design and utilization of new instructional technologies. A mixture of methodologies is highly recommended for research on instructional media.

7. A method for further examining the form and function of the computer graphics would be to use interview techniques to elicit descriptive words that could then be arranged on Likert scales or constructed as semantic differentials and analyzed factorially.

8. Which animation materials to present for a study, either experimentally or qualitatively designed, is problematic because the state of the art keeps changing. A new animation entitled "Gears", is a fascinating study of interpolating gears but was unavailable at the time of this study. It is a breath-taking visual experience, and it may have had a major influence on the results of this study had it been used, especially with physics and math teachers. As results from one set of animations are tested against newer animation techniques,
generalizations may evolve that will hold true over time regardless of the technology. On the other hand, the inherent tentativeness of theory that is due to a changing body of knowledge and technology is especially apparent when studying the social and cognitive effects of state of the art technology.

9. Questions for further research that could be pursued are:

a. How is picture comprehension affected by movement along the z axis (depth)? Is comprehension affected by developmental stage?

b. Would modeling the movement of eyepoint from frontal view to an overhead view of a city enhance map reading skills? Which direction of movement would be most beneficial—top to front or front to top or both?

c. Would practice in recalling the sequence of eyepoint change in a rotated scene enhance development of spatial orientation?

d. Could saturation with moving visuals that show multiple perspectives generalize to the development of empathy? In other words, if a person continually "sees" things from different points of view, will that person be more able to think about things from multiple points of view?

e. Would viewing the interpolation of objects from 2D to 3D enhance the student's understanding of solid and plane geometry? Would manipulation of the objects while the rotation of the object is being visually modeled further enhance comprehension?

f. Are there sex differences in the comprehension of spatial information presented during animated rotations and interpolations?
The advantages of animation have been documented by researchers, designers, as well as the teachers in this study; animation captures the viewer's attention, provides salience to critical features, enables the viewing of things or processes that are unavailable due to cost or accessibility, allows the temporal and spatial control of visual phenomena, among other things. In addition, because three dimensional computer generated animation enables the control of visual phenomena in three space, the modeling of dynamic systems is more possible now than ever before. Furthermore, the designer has an infinite number of color, perspective, lighting, and movement options from which to make the animation as instructionally effective and as aesthetically pleasing as the imagination and training can allow.

The use of high resolution computer generated animation for instruction in public schools is not yet a reality but becomes increasingly so as hardware and production costs continue to drop. As computer generated animation is implemented as an instructional tool, several questions emerge in an attempt to avoid inappropriate or misguided use: a) What will be the content and the nature of its use, and b) who will be making those decisions of content and utilization?

The purpose of this study was to provide a forum for classroom teachers to react to the form and content of state of the art computer generated graphics in order to assess instructional applications, curricular impact, and utilization. Teachers were accessed because they are the practicing professionals who are not only sensitive to what works in the classroom, but they also decide what will be used in the classroom. Computer generated animations were the media identified
for study because of the opportunity and importance of taking a
proactive approach to design and implementation of new technology.

The data suggest that teachers saw in the computer graphics'
opportunities for teaching about abstract concepts and encouraging
higher cognitive processing, perceived by the teachers as valuable
instructional activities. Furthermore, the teachers appreciated the
manner in which computer generated animation provides modeling of
dynamic phenomena in three dimensional space. The data further suggest
that utilization of computer generated animation would be enhanced by
its manner of delivery: television receivers and videocassette
recorders, both highly visible and available technology. The data also
revealed categories of educational concern as teachers approach the
adoption of a new technology: autonomy of the teacher, an opportunity
view of curriculum, and instructional media as a form of human
expression. The study serves as a first step in exploring the
instructional utilization and curricular impact of computer generated
animation in classrooms.
APPENDIX A

LETTER OF INTRODUCTION
March 18, 1985

Mark Stevens, Superintendent  
Groveport Madison Local Schools  
5055 South Hamilton Road  
Groveport, Ohio

Dear Mr. Stevens,

Ms. Sue Minor has brought to our attention the linkage that you are trying to establish between Groveport Madison Local Schools and The Ohio State University. Our research appears to be appropriate for your project not only because we need access to classroom teachers but because we think the teachers would enjoy participating in this study. As we had discussed with Sue, we want to provide a forum for classroom teachers to experience and react to state-of-the-art computer generated animated graphics in order to examine how these electronic images could affect the content of curriculum.

State-of-the-art computer generated graphics have become quite pervasive in advertising, the movie industry, and the art world. These graphics will likely become available as instructional tools as production costs come more in line with educational markets. It is our belief that the classroom teacher is an important link between development and implementation and is a viable source whose perceptions of the utility of computer graphics is not only to be understood but also to be sought. By presenting these graphics to teachers, we hope to uncover instructional needs that could be met by these images and to identify new curricular content. This information base is intended to provide direction to designers for generating and testing computer generated animation in instruction.

For this study, we will need access to approximately twenty teachers who are currently teaching in grades kindergarten through eighth grade. Purposeful, snowball sampling will be used, so teachers to be interviewed will be identified initially through building principals or supervisors and thereafter through the nominations of previous informants. Our intent is to interview teachers who are generally known to be perceptive and innovative professionals.
We will be conducting individual interviews during which videotapes of the animations will be shown. We anticipate two 30-45 minute interviews with each teacher, and a third session during which a Q Sort will be administered. The Q Sort is a simple procedure where the participant subjectively sorts a number of cards that contain statements, themes, and hypotheses that have emerged during the interviews.

The Q sort is intended to complement and extend the data from the interviews. Any information obtained will, of course, be confidential, and the rights of and respect for the teachers will be maintained at all times. A copy of the consent form is enclosed.

One of us will be calling you in a few days to confirm receipt of this letter and to discuss further details with you. Thank you very much for your time.

Cordially,

Patti R. Baker
Graduate Research Associate

John C. Belland
Associate Professor

Enclosure

cc: Sue Minor
Dear ...

Thank you for agreeing to participate in my research regarding the uses of computer generated animation graphics. As previously discussed, the time for the first of two interviews has been scheduled for April 24, 1985 at 7:40 A.M. I will meet you in the office.

I have enclosed a copy of an article that describes the production and present use of these graphics. Reading this article before we meet may give you some idea of the types of computer images you will be viewing.

I am looking forward to meeting you.

Cordially,

Patti R. Baker
APPENDIX C

PERMISSION FORM
CONSENT FOR PARTICIPATION IN SOCIAL AND BEHAVIORAL RESEARCH

The Ohio State University

I consent to participating in research entitled STATE-OF-THE-ART COMPUTER GENERATED GRAPHICS AND THE EMERGING CURRICULUM: TEACHERS' PERCEPTIONS OF POSSIBILITIES. The investigator, Patti R. Baker, has explained the purpose of the study, the procedures to be followed, and the expected duration of my participation. Possible benefits of the study have been described as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Further, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me. The information obtained from me will remain confidential.

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ___________________ Signed: ____________________

(Participant)
APPENDIX D

FIRST INTERVIEW SCHEDULE
**INTERVIEW GUIDE – 1st Visit**

Name: _______________________________________________________ Subject No. _____

Date:______________________________ Location:____________________________

**Introduction:** I am doing a study of selected teachers on the topic of how they perceive the instructional usefulness of computer generated animation. This is the first of two visits in which I will show you some videotapes and ask you some questions. The interviews will take about a half hour each, and I would like to tape each interview so I won't miss anything. Is that OK with you?

Your name and all identifying characteristics will be kept confidential. What you tell me will be put together with other interviews I am doing and will be reported only in terms of general, collective, views of teachers about these topics.

The videotapes that I will be showing you today were produced by Cranston/Csuri Productions in Columbus, Ohio. These tapes are used as demos for potential advertising clients. These types of electronic images will likely be available for educational use as production costs come down, and will be useable in many forms: still photographs, 16mm film, videotape, interactive videodisc, and slides, to name a few. As a designer, I want to know how teachers could use graphics like these: to teach what has not been possible to teach, to teach something earlier perhaps, or to teach what has not been identified before as appropriate to teach.

First, I want to ask you a couple of questions.

1.10 Thinking back through the year, which of these tools do you use nearly daily in your teaching? (Card of possible choices)

1.12 Which do you use about once a week?

1.13 Which do you use about once a month?

1.14 Which do you use about once or twice a year?

- a. texts D W M Y
- b. worksheets/paper D W M Y
- c. chalk and chalkboard D W M Y
- d. overhead projector D W M Y
- e. tape recorder D W M Y
- f. film projector D W M Y
- g. computer D W M Y
1.3 If I were a student teacher, and I asked you which would be more appropriate for teaching a particular concept, realistic film photography or animated film, what would be your advice?

1.31 What is most important to you in the way you arrange your instruction?

First, I'm going to show you some animation that was developed for Goldcrest Films "The Living Body." Watch this animation for possible ways it could be used in your classroom to enhance what you are already teaching or to provide an opportunity to teach new content.

*** MEDICAL DEMO ***

1.4 Any first impressions to what you saw?

1.5 What kind of student would these kinds of images especially benefit?

1.6 What type of student would these images possibly be detrimental to?

1.7 What new content would you like or could you teach given these images?

1.8 What could you teach differently given these images?

The next videotape animation I'm going to show you is a collection of short animations that are shown to potential commercial clients. It is very flashy, but some unusual visual effects have been achieved. Try to see if you can see any instructional applications of these images.
1.9 As a teacher, what did you especially like about this tape?

1.10 Also as a teacher, what did you not like?

1.11 How would you describe the motion that you saw in this animation as compared to the Medical Demo?

Biographical Information:

1.20 How long have you been teaching?

1.21 What grades have you taught?

1.22 Present grade or position?

1.23 How long have you been teaching this grade?

1.24 What educational experience have you had?

1.25 Age __

1.26 Sex __

2nd interview scheduled for: ___________________________
APPENDIX E

SECOND INTERVIEW SCHEDULE
INTERVIEW GUIDE - 2nd Visit

Name: _____________________________ Subject No. ___

Date: _______________ Location: _______________

2.1 When I was a classroom teacher, I remember certain subjects or units that were especially enjoyable to teach. What subjects or topics do you find most satisfying to teach and why?

2.2 If you could design your own curriculum, what sort of things would you like to teach that you aren’t able to teach now?

2.3 Last week I showed you several animated films. Did you have any flashbacks to them during the week? If so, what were the context and content of your flashbacks?

Now I’d like to show you another animation. Where the ones you saw last week were slick and flashy for commercial use, this next tape will appear different. It’s not as flashy, but it served as an exercise for the designers to solve some very difficult and complicated problems in computer generated animation. This sequence won an international prize last fall.

*** SNOOT & MUTTLY ***

2.4 What did you see in this film?

2.5 The intent of Snoot & Muttly is to entertain. Is the animation also educational? If so, in what way? If not, why not?

2.5b How could it be made more educational?

I’m going to show you an animated film that was designed expressly for instructing. The purpose of the lesson is to relate the edge of a cube to its volume. The lesson itself is not particularly well designed, but I want you to look at it for its properties that are especially instructionally effective to you. Keep in mind that altering computer generated animation is very easy, so if you have suggestions as to what could be done to make the sequence more effective, I would be very interested in hearing them.
** The Cube **

2.6 Any first impressions?

2.7 (Open discussion on the benefits and limitations of this animation)

I'm going to show you one more tape. This is a simulation game called TAXI. This demonstration will give you an idea of how these graphics can be used in an interactive environment.

*** TAXI ***

2.8 If you had to 'sell' this interactive package to a client, what would be your arguments for the benefits of this animation?

2.9 If you had an instructional package competitive with the one you just saw, what aspects of 'your' design would be better than the other?

2.10 Whom would you recommend as someone who would be interested in seeing these graphics and would be willing and able to talk about their possible uses?

_________________________________________  _______________________
(Name)  _______________________
(Phone)  

_________________________________________  _______________________
(Name)  _______________________
(Phone)  

Q Sort Appointment

Home Phone: _____________________________

Home Address: __________________________

Vacation Plans: __________________________

Tentative Date: __________________________
APPENDIX F

DIRECTIONS FOR Q SORT
Today I am going to ask you to sort cards that contain statements made by teachers I interviewed and by other educators as well. You are to sort them according to how much you agree with the statements. In other words, if a statement accurately describes how you operate in the classroom, how you feel about teaching, and so forth, then you would place that card somewhere near "Most Agree." Please be assured that there are no 'good' or 'bad' statements. These statements were simply made by teachers who were describing their professional environments and opinions. I am looking for some kind of consensus of opinion or trends of thinking.

To make the sort go faster, it will help if you first sort the cards into three piles as indicated by the labels I have put on the table. (Place the MOST AGREE, LEAST AGREE, and NEUTRAL cards in front of the teacher. Hand the teacher the shuffled Q sort cards.) Without taking too long with each card, place each card on the stack that corresponds with your opinion. This is a preliminary step, so sort according to your initial reaction. You may change the placement of the cards if you wish.

Now I want you to be more specific with the sort. (Place the numbered cards down in front of the teacher.) Notice that you can place only a specified number of cards in each pile. Try not to take too long with each card, but remember that you can change the placement of any card whenever you want. Feel free to ask questions if you need to.
APPENDIX G

REFERENCED Q ITEMS
ad12. Revolution in education will not come through technology, although it will be aided by it. It will come as we shift the role of both the teacher and the student (Wagner, 1973:3) ** I think this is Dale, check source).

ael3. It appears that a constant process of discovery is going on, as over and over we hear of profound new insights being carried from one art or discipline to another because an idea or phenomenon has been recorded and seen on film. (Pearson, 1973:63)

bc24. The school, like the industrial plant, represents a process. Raw material goes in and a product comes out. The change that occurs between input, that is the entering pupil, and the output, the departing pupil, measures the school. (Meade, as cited by Tanner and Tanner, 1975:31)

bd29. Teaching can be defined as an arrangement of contingencies of reinforcement under which behavior changes. (Skinner, 1968:29)

be32. There are two kinds of people in the world: those who love machines and those whom machines are out to get. I am one of those whom machines are out to get. (Hait, 1983)
APPENDIX H

DATA MATRIX OF THE Q SORT

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