THE DaVinci Project

Multimedia for Art & Chemistry

IOWA STATE UNIVERSITY
COLLEGE OF EDUCATION

TABLE OF CONTENTS

U S WEST FOUNDATION

MULTIMEDIA AND EDUCATION

Proposal Summary Fact Sheet

Project Title: The DaVinci Project: Multimedia For Art and Chemistry

Applicant: College of Education, Iowa State University of Science and Technology

Project Director: Michael Simonson, Professor

Address: E005 Lagomarcino Hall, Iowa State University

City: Ames State: Iowa Zip Code: 50011

Telephone: 515-294-7009 Fax: 515-294-9284

E-mail: mrs@IASTATE.EDU Federal ID#: 42 - 600 - 4224

Project Summary: The DaVinci Project proposes to bring together chemistry and art teachers from ten Iowa school districts and to unite them with chemists, artists, teacher educators, and teacher education students. These professionals will become DaVinci scholars who will collaborate to develop the DaVinci Multimedia System, an interactive multimedia system that integrates concepts in art and chemistry. The DaVinci System will consist of visualizations created by the DaVinci scholars and stored on a compact disc, a series of multimedia computer-based lessons that allow easy and varied access to the system, and inservice and preservice staff development activities for the DaVinci scholars and for other teachers and teacher education students.

Amount requested from U S WEST:	$ 298,840
Amount from applicant:	$ 150,913
Amount form other sources:	$ 30,000
Total Budget:	$ 479,753

Program Director: Michael Simonson

Michael Simonson

December 6, 1994

Contract and Grants Officer: Richard E. Hasbrook

Richard E. Hasbrook

12-9-94

The DaVinci Project:
Multimedia in Art and Chemistry

SUMMARY

The development of this proposal was a collaborative effort of art, chemistry, and education faculty, and teachers from five central Iowa school districts. The writing team worked for almost two months to develop the plan described in this proposal. One of the most significant events of the writing activity was the identification of the project's name - the DaVinci Project. This name served as a *mental model* that guided the deliberations of the writing team, and will direct the activities of those who participate in completing its activities.

The DaVinci Project proposes to bring together chemistry and art teachers from ten Iowa school districts and to unite them with chemists, artists, teacher educators, and teacher education students. These professionals will become DaVinci scholars who will collaborate to develop the DaVinci Multimedia System, an interactive multimedia system that integrates concepts in art and chemistry. The DaVinci Multimedia System will consist of visualizations created by the DaVinci scholars and stored on a compact disk, a series of multimedia computer-based lessons that allow easy and varied access to the system, and inservice and preservice staff development activities for the DaVinci scholars, and for other teachers and teacher education students.

Materials will be developed during the project according to a concept map with three levels of sophistication - structures, interactions, and applications. During the first phase of the project, art teachers will collaborate with other art educators to develop lessons that promote visualization, visual thinking, metaphoric thinking, and visual logic. At the same time, chemistry teachers will collaborate with other chemistry educators to develop lessons at the microscopic, symbolic and macroscopic levels.

During the second phase of the project, artists and chemists will continue to collaborate with each other, but will increase the level of interaction with their counterparts. Multimedia visualizations in art and chemistry will be accessed by the lessons created. Finally, in phase three, interactions between the two disciplines will be multiple and varied. The relationships between art and chemistry will be clearly identified. During the entire project, teacher educators and teacher education students will learn from, collaborate with, and promote interactions between art and chemistry teachers.

The final DaVinci Multimedia System will include compact disks, multimedia lessons, and staff development materials. These materials will be available on-line through the New Art Basics system and through the Iowa General Chemistry Network, and in a package for use by those who do not have networking capabilities.

The DaVinci Project:
Multimedia in Art and Chemistry

DESCRIPTION OF PARTNERS

Three departments, three units, and five school districts collaborated to develop the DaVinci Project proposal. The departments, units, and schools had collaborated prior to the development of this proposal, but not for the specific purpose of developing multimedia materials for art and chemistry.

This partnership should be considered a new one. It began in October of 1994 when a discussion group was convened by the College of Education at Iowa State University to discuss plans to respond to the U S West Request For Proposals. The writing team was expanded by inviting the participation of chemistry education faculty, art education faculty, and teachers from school districts with a tradition of collaborating with the College of Education. These groups collaborated several times to develop the plan for the DaVinci Project, and sections of the proposal were contributed by members of this group.

The College of Education's Department of Curriculum and Instruction will assume leadership for the DaVinci Project. Collaborating departments at Iowa State University will include the Art and Design Department of the Design College, and the Chemistry Department of the Liberal Arts and Sciences College. Three ISU support units will also be partners - the Design Visualization Laboratory, the Interactive Courseware Development Laboratory, and the Research Institute for Studies in Education. These organizations and the resources they will bring to the project are described in the body of the DaVinci project proposal.

Five school districts of varying size and from rural, suburban, and urban communities are partners of the project (Ankeny, Ames, Des Moines, Gilbert, Roland-Story). Teachers and administrators from these districts participated in the planning and writing of the DaVinci Project proposal, and will continue to participate as steering committee members. These five schools districts and the resources they will bring to the project are described in the body of the DaVinci project proposal.

The DaVinci Project:
Multimedia in Art and Chemistry

INTRODUCTION

All passes, Art alone
Enduring stays to us;
The bust outlasts the throne -
The coin, Tiberius..
Ars Victrix, (1876)
H. Dobson

...so that the aim of exact science is
to reduce the problems of nature
to the determination of quantities
by operations with numbers.
On Faraday's Lines of Force (1856)
J. Maxwell

The most beautiful thing
we can experience
is the mysterious.
It is the source of all true art and science.
What I Believe (1930).
A. Einstein

Oh, East is East, and West is West,
and never the twain shall meet, ...
The Ballad of East and West (1889)
R. Kipling

Two Cultures - Art and Science

Artists and scientists are thought to inhabit two distinct worlds, what C.P. Snow called "The Two Cultures." Chemistry, possibly the most "distant" of the sciences, is the "study of the composition and properties of substances and with the reactions by which substances are produced or converted into other substances." Chemistry is considered by some to be the domain of the unusually detailed, or the distinctly logical.

Art, the development of "creative works that make or display form, beauty, and perception," has been characterized as the most pleasing of human activities. Art is creating, and is considered by some to be the domain of the unusually, even divinely, inspired, or distinctly insightful.

The relationship between art and the science of chemistry is not readily obvious or even discussed with the student of either. However, when examined more closely - examined more scientifically and more artistically - the scientist and the artist have often been found to be one and the same. "Most imaginative scientists are also artists, poets, musicians or writers" (The Creative Process, 1985). This connection was proposed by J.H. van't Hoff, a poet and the first Nobel laureate in chemistry in 1878. Van't Hoff's study of more than 200 early biographies of scientists supported his contention about the close relationship between chemistry and art.

Recently, Robert Root-Bernstein, a science historian, continued van't Hoff's work and found creative processes as the unifier of art and science. The two cultures concept, postulated by Snow, was not between scientists and artists, according to Robert Root-Bernstein in his study of

150 scientists, but between those who innovate and create and those who do not. Great artists and chemists are innovators - they create. He found that nonverbal forms of thought, especially visual thinking and mental modeling, were more important to successful scientists than verbal forms of thinking.

The same is true of artists. The ability to imagine new artistic realities is correlated with playing, modeling, abstracting, idealizing, harmonizing, analogizing, pattern-forming, approximating, and extrapolating. Creativity is related to the ability to take a problem - How do chemicals exist? - and translating it into another form, such as an analogy, a model, or picture, that is more easily manipulated mentally. Then, the problem can be translated back into some verbal or mathematical form. Root-Bernstein felt that the ability to transfer ideas between modes of intelligence may be a key to success for both the artist and the chemist (The Creative Process, 1985).

It is the belief that art and science are inter-related that prompted the name for this project. Leonardo DaVinci, considered by most to be an artist, but known by scientists to be one of their own, was an accomplished artist and a visionary scientist. The use of DaVinci in the title of this project will serve as a *mental model* for those who participate in it. If mental models are "representations that are active while solving a problem and that provide a workspace - a mental workspace - for inference and mental operations" (Gentner & Stevens, 1983), then DaVinci will serve as an image to guide the activities of this project, which at its most fundamental level is the development of synthesis between art and chemistry, artists and chemists.

This project will bring together scholars from a variety of venues. It will identify students of chemistry and art, teachers of chemistry and art, and researchers in chemistry and art, and will place them in a situation that fosters collaboration - the development of multimedia materials that visualize and explain basic issues and concepts in the teaching of chemistry and the practice of art.

The process will begin with groups of chemists and artists, and will move to a gradual melding of them into teams of "artistic scientists" - DaVinci scholars - who work together and learn from each other. This merger will be apparent in the multimedia materials created, and also in the people involved. Teacher education students will participate as colleagues and will provide an on-campus link between teachers and teacher educators.

Overview of the Proposal

This proposal will discuss the need for this project and how specific activities will be identified. Second, a detailed plan of operation will be explained which will include an overview, a listing of project goals, objectives, and activities, and a management system that identifies those who will be responsible for completing the project.

Third, there will be an explanation of how this project will build upon two existing projects, one in art and one in chemistry. Fourth, the organizations that are supporting and committed to the successful completion of this project will be discussed. The project's comprehensive evaluation plan will be described, and finally, the budget and the budget explanation will show how U S West resources will be applied in a cost-effective manner to the proposed activities. While the collaboration between those who consider themselves to be chemists and those who consider themselves artists is at the foundation of this proposed project, specific deliverables will be produced and made available as testimonials to the effectiveness of cooperation between the professions.

NEED FOR THE PROJECT

Recently, considerable attention has been directed toward the need to improve the quality of education and increase the measurable abilities of students. One trend that has galvanized efforts in various disciplines is the move to develop clear standards for achievement. This project will concentrate on the published standards in art and science to insure that efforts are in concert with other educational reform activities.

Standards in Art and Science - Collaboration

Published standards in art and science will serve as guides for the development of the activities of the DaVinci Project. Additionally, the National Education Goals - Goals 2000 will provide direction to the project. In Iowa, a new Framework For Art Education has recently been made available. This document proposes a "Scope, Sequence, and Strategies" for learning in art. Aim 1 of the Framework proposes "guiding students to perceive, comprehend and evaluate the visual world." The purpose of this aim is to "awaken students to the visual characteristics of the natural world and the world created by humans."

Aim 3 is to "motivate students to develop and communicate imaginative and inventive ideas." The purpose of this aim is to promote fresh ways of thinking and new methods of visualization, and to see experiences from a different perspective, freeing new concepts to emerge. The DaVinci Project's activities will foster these aims for chemists, artists, and teacher education students.

Additionally, the National Visual Art Standards stress the "making of connections between visual arts and other disciplines." This will be accomplished with special emphasis on the second national content standard of "using knowledge of structures and functions" which will be a basic component of the DaVinci Multimedia System.

Standards for science are still in the development stage. It is anticipated that standards will be published by the National Academy of Science early in 1995, and will be considered during the development of project activities. Draft versions of the standards have been reviewed and are reflected in the goals, objectives, and activities of this project.

Also of particular interest to this project is National Education Goal 3 which indicates that learners in the year 2000 will be competent in core subjects. The plan for the DaVinci Project is to produce a replicable process and widely usable multimedia materials that promote competence that is fundamental and systemic in art and chemistry - materials that build a linkage between the two areas. It is at the intersections between the artificial limits of traditional disciplines that true competence is found.

Needs Assessment - Process and Expectations

The relationship between science, particularly chemistry, and art have been discussed in the literature for decades, even centuries. However with a few exceptions, the specific ways that practitioners from the two disciplines can collaborate have not been clearly identified. Early during the implementation of the DaVinci Project two activities will occur. First, a survey of a sample of chemistry and art teachers in Iowa will be conducted. This survey will be based on the extensive review of the literature that was part of the activities of the proposal writing team.

Second, a focus group will be held. The purpose of these needs assessment activities will be to publicize the project and to identify the most appropriate topics for visualization and delivery as part of the DaVinci Multimedia System.

Survey of Art and Science Teachers

DaVinci Project staff, after consulting with needs assessment specialists from the Research Institute for Studies in Education (RISE) at Iowa State University, will develop a survey "Issues in Chemistry and Art" (ICA) with three categories of questions. First, specific items about the relationship between chemistry and art will be included. Second, open ended questions that permit the respondent to propose ideas will be asked, and finally, there will be demographic questions about the person responding to the ICA survey.

The survey process will be carried out in three phases. First, information about similar activities reported in the literature will be evaluated. Second, existing instruments will be identified and appropriate portions will be incorporated into the ICA. Finally, the ICA will be mailed to 100 art teachers, 100 chemistry teachers, 10 science education professors, and 10 art education professors. Results will be analyzed, and recommendations will be made.

Focus Group

Results from the ICA will be summarized and used during a focus group meeting. The focus group will be used to clarify and "focus" the subsequent activities of the DaVinci Project. Thirty DaVinci scholars will be identified to participate in the focus group - 10 chemistry teachers, 10 art teachers, and 10 teacher education students. The DaVinci Project steering committee members will also participate. The focus group activities will be coordinated by specialists from RISE.

PLAN OF OPERATION

The plan of operation for this project will consist of three components: the conceptual organization of the project's activities; the project's specific goals, objectives, activities, and deliverables; and the project's management plan.

Overview of the Plan

On many levels, and to many people, chemistry and art are not easily correlated. For the DaVinci Project a conceptual framework for the development of project materials and activities has been identified. This framework is based on three levels of complexity of ideas: structures; interactions between and among structures; and the applications of structures and interactions to the everyday, observable environment (Figure 1). The development of higher order thinking skills will be fostered during the entire project, especially during the development of the third phase of the DaVinci Multimedia System.

Three Levels - Structures, Interactions, and Applications

Structures are defined as the fundamental building blocks of the discipline. For example, chemists have the Periodic Chart of the Elements, the Scientific Method, and logical techniques of inquiry as building blocks. Artists have the elements of design, color relationships, and techniques of perspective that they use in a variety of situations to develop artistic creations. Chemistry students and art students learn these and other "structures" in their courses of study.

Interactions require the learner to utilize basic knowledge during the development of more complex ideas. Chemists mix chemical elements according to formulas to form compounds.

Artists combine design elements in the visualization process according to established principles to create art. In both cases more complex realities are produced.

Ultimately, the learner should be able to understand the applications of art and chemistry. The multimedia materials created will permit students to experience and understand the chemistry of living and non-living things, and appreciate and react to the beauty and purposefulness of their experiences.

Further, the multimedia materials created by the DaVinci Project will heighten the learner's understanding of chemistry concepts by helping the learner to approach problems in the same ways as do professional chemists. It has been suggested (Herron, 1990) that professional chemists have the ability to operate using three levels of representation: symbolic representations, such as formulas and equations; the microscopic representations of atoms and molecules, and macroscopic events (see figure 1).

Studies by Gabel and Sherwood (1984) and Gabel, Sherwood, and Enochs (1984) indicate that the majority of high school students solve chemistry problems using only algorithmic methods (plug numbers into a formula). These students do not possess an adequate representation of the chemical concepts needed to understand the problem.

The DaVinci project will attempt to build a model of collaboration that results in the development of multimedia materials that can be used to demonstrate the relationships between art and chemistry. Figure 2 shows the sequence of activities in which artists will collaborate with chemists and chemists will collaborate with artists to develop realistic and accurate visualizations of art and chemistry structures, interactions, and applications. Ultimately, multimedia materials will be developed that "cross over" from art to chemistry and chemistry to art. At the same time, DaVinci scholars will "cross over" in their understanding of art, and their understanding of chemistry.

Project Goals, Objectives, and Activities

Goal 1 - Collaboration will be increased between the ISU College of Education, Department of Art and Design, Chemistry Department, teachers in local schools, and specialists in multimedia and visualization.

Objective 1.1: A steering committee of teacher educators, art educators, chemistry educators, art and chemistry teachers, visualization specialists, and multimedia experts will be established.

- a project management team will be identified by the DaVinci Project's principal investigators during the first 90 days of the project.
- the project management team will be responsible for all reports and budget explanations.
- the steering committee will direct the activities of the project. It will have members who are teacher educators, art teachers, and chemistry teachers.

Objective 1.2: DaVinci Project activities will be conducted by art teachers, chemistry teachers, and teacher educators working collaboratively.

- 100 art teachers, 100 chemistry teachers, 10 art education professors, and 10 chemistry education professors will be surveyed to identify art and chemistry concepts related to structures, interactions, and applications.
- 30 DaVinci scholars will be identified - 10 chemistry teachers, 10 art teachers, and 10 teacher education students. The DaVinci scholars will work together for two years to develop the DaVinci Multimedia System.

- DaVinci scholars will meet monthly using distance education technologies, and in two intensive on-campus workshops each year.
- DaVinci scholars will routinely collaborate using telecommunications. Each scholar will have a computer that is connected to the Internet.

Goal 2 - Innovative multimedia materials that incorporate basic concepts in art and chemistry will be developed and used.

Objective 2.1: Visualization materials that present chemistry concepts microscopically, symbolically, and macroscopically will be developed at three levels - structures, interactions, and through applications.

- the Design Visualization Laboratory will work with DaVinci Project staff and scholars to produce prototype visualization materials for chemistry that are evaluated, revised, and produced in final form on a compact disc.

Objective 2.2: Visualization materials that present art concepts through visualization, visual thinking, metaphoric thinking, and visual logic will be developed at three levels - structures, interactions, and through applications.

- the Design Visualization Laboratory will work with DaVinci Project staff and scholars to produce prototype visualization materials for art that are evaluated, revised, and produced in final form on a compact disc.

Objective 2.3: Multimedia lessons that use chemistry and art visualization materials will be developed.

- the Interactive Courseware Development Laboratory will work with DaVinci Project staff and scholars to produce prototype computer-based multimedia lessons that permit non-sequential, random, user-constructed access to visualization sequences and that demonstrate effective learning in art, chemistry, and the relationships between the two disciplines, especially leading to higher order thinking skills. These prototype materials will be evaluated, revised, and produced in final form for on-line and on-disc access.

Goal 3 - Learning opportunities in art and chemistry will be enhanced through the use of multimedia materials.

Objective 3.1: DaVinci scholars in art and chemistry will work with teacher education students to develop and revise multimedia materials.

- visualization and computer-based multimedia instruction will be developed according to the conceptual framework shown in Figure 1.
- teacher education students will pilot-test prototypes and final versions of multimedia materials in participating teachers' art and chemistry/science classes. Elementary and secondary level classes will participate.

Objective 3.2: DaVinci Multimedia System materials will be made available over interactive telecommunications networks, such as the Internet.

- the New Art Basics and the General Chemistry Network Project computer servers will be linked and the DaVinci Multimedia System materials added for on-line access by teachers and teacher educators in Iowa and the nation.

Goal 4 - Training modules for inservice and preservice teachers will be developed and provided, and these materials will be incorporated into teacher education curricula.

Objective 4.1: Inservice and staff development for teachers will be a major activity of the project.

- two intensive workshops will be held each year for participating DaVinci scholars.
- during the second year of the project a DaVinci Multimedia Exposition will be held. Art and science educators will be invited to attend.
- during the second year of the project a curriculum plan for using the DaVinci Multimedia System materials will be produced, pilot-tested, revised, and distributed in an on-line electronic version and in a traditional packaged format.

Objective 4.2: Preservice teacher education programs will use DaVinci Multimedia System materials in methods of teaching courses.

- DaVinci Multimedia System materials will be incorporated into teacher education courses in science, art, and technology at Iowa State University, and will be made available to other teacher education programs.

Goal 5 - Needs assessment and evaluation will be used in the planning, implementation, and summarization of the project.

Objective 5.1: Needs assessment activities will be used to direct project activities.

- needs assessment activities will be planned, conducted, and results reported by the Research Institute for Studies in Education during the first year of the DaVinci Project. Results will be used to develop additional project activities.

Objective 5.2: A comprehensive evaluation plan will be an ongoing component of the project.

- the evaluation plan for the DaVinci Project will be implemented at the beginning, during, and at the conclusion of the project by an evaluation team from the Research Institute for Studies in Education.
- needs assessment and evaluation reports will be submitted quarterly, as appropriate.

Deliverables

The fundamental purpose of the DaVinci Project is the amalgamation of art and science, artists and scientists. Concrete deliverables will provide evidence of the project's collaborative efforts. Deliverables are categorized into two areas: project reports and instructional products.

Project Reports:

- quarterly reports will be submitted by the project's management team. These reports will be delivered to the DaVinci steering committee, and to U S West officials.
- needs assessment and evaluation reports will be submitted periodically. These reports will support and supplement the project's quarterly reports.
- a final report will be submitted within 180 days of the completion of the funding period. This report will review the project's goals, objectives, and activities, and will discuss ongoing plans for the DaVinci Project.
- presentations at professional meetings, and publications in professional journals will be activities of DaVinci scholars. These presentations and publications will discuss the process and outcomes of the DaVinci Project for review and modeling by others in art education, chemistry education, and teacher education.

Instructional Products:

The DaVinci Multimedia System for Art and Chemistry will consist of three components. First, there will be a compact disc containing a large number of visualization sequences in both art and chemistry. These sequences will include images in art and chemistry related to structures, interactions of structures, and applications.

Second, multimedia lessons will be produced and made available electronically both on-line and on-disc. These computer-based lessons will permit the hypermedia exploration of the entire system. The first phase of the development of the system will be for use within either art or chemistry. The second phase will be designed to access information contained on the compact disc in either art or chemistry, and the final phase will be designed to allow true hypermedia/multimedia utilization of the entire system. The cross over between art and chemistry will be seamless (Figure 1).

Finally, there will be printed and electronic lesson plans that contain information for the training of preservice and inservice teachers. These lessons will provide teacher education students, teacher education faculty, and practicing teachers with training in the use of the system.

The DaVinci Multimedia System for Art and Chemistry will be accessible on-line, and also distributed in a package. All components will carry the DaVinci logo to permit easy identification as part of the system. Additionally, staff development materials for art and science teachers will be produced. These materials will consist of printed notebooks with lessons plans, references, and information about the appropriate use of the DaVinci Multimedia System. Finally, a DaVinci Multimedia Exposition will be held, featuring the DaVinci Multimedia System.

Management Plan

Organization Plan

The organization plan for this project is shown in Figure 3. The project will be managed by the principal investigators who will supervise the activities of the part-time project manager, two part-time graduate students, and a part-time secretary. A steering committee will oversee the activities of the project and will provide advice to the management team.

Technical assistance will be provided to the project by Iowa State University organizations that specialize in visualization, multimedia development, needs assessment, and evaluation. These support organizations--the Design Visualization Laboratory, the Interactive Courseware Development Laboratory, and the Research Institute for Studies in Education--will be contracted with to provide technical assistance to the DaVinci Project. Project reports and instructional materials will be produced as deliverables in a timely manner.

Key Personnel

Development of this proposal has been a collaborative effort involving over a dozen university and school personnel. These individuals will serve on the project's steering committee. The steering committee will be led by the project's co-principal investigators.

The DaVinci Project will have four co-principal investigators. Michael Simonson, Professor of Curriculum and Instruction, will serve as project coordinator. Gary Downs, Professor of Curriculum and Instruction will serve as the liaison to the College of Education teacher education program. Dennis Dake, Associate Professor of Art and Design, will coordinate the art education activities of the DaVinci Project, and Thomas Greenbowe, Associate Professor of Chemistry, will coordinate the chemistry component of the project.

Michael Simonson has been involved in the teacher education program at Iowa State University since 1972. His specialty is in the effective applications of technology to education. He has considerable experience in multimedia, computer education, and distance education, and has served as principal investigator for several externally funded projects, including a

component of a multimillion dollar project funded by the U.S. Department of Education's Star Schools Program.

Gary Downs specializes in science education in the Department of Curriculum and Instruction. He has considerable experience in methods of science teaching, and has worked extensively with children and teachers in innovative techniques for science education. Dr. Downs has served as the principal investigator for a number of externally funded projects.

Dennis Dake has served in the Art and Design faculty in the College of Design for 20 years, and has considerable experience working with art teachers in Iowa. He is very active in the visual literacy movement and is the creator of the New Art Basics program that the DaVinci Project will build upon.

Thomas Greenbowe has been with the Chemistry Department in the College of Liberal Arts and Sciences since 1990. He is coordinator of ISU's general chemistry program that is responsible for teaching chemistry to undergraduates. He is a researcher in chemistry education, and is a co-principal investigator of the "Iowa General Chemistry Network Project".

The members of the DaVinci Project proposal writing team will also serve as the project's steering committee. In addition to the project's four co-principal investigators the steering committee includes:

- Krishna Athreya, Program for Women in Science and Engineering
- Susan Beers, Curriculum Coordinator, Roland-Story Community Schools
- Karlene Garn, Technology Coordinator, Ames Community Schools
- David Graf, Coordinator for the Interactive Courseware Development Laboratory
- Ken Hartman, Chemistry Teacher, Ames Community Schools
- Steven Herrnstadt, Associate Professor of Art and Design, and Coordinator, Design Visualization Laboratory
- Gregory Nelson, Chemistry Teacher, Gilbert Community Schools
- George Parkinson, Art Teacher, Ankeny Community Schools
- Sue Swartz, Technology Consultant, Des Moines Community Schools
- Sherrie Schleorke, Art Teacher, Gilbert Community Schools

Existing Projects

The DaVinci Project will build upon and draw expertise from two existing multimedia projects at Iowa State University. First is the New Art Basics Program, founded by Dennis Dake. The second is the Iowa General Chemistry Network Project, headed by Thomas Greenbowe. These two projects are attempts to provide resources to art and chemistry teachers. The considerable experience gained from these projects will assist the DaVinci Project staff. Additionally, the New Art Basics network, and the General Chemistry network will be used to distribute prototype and final versions of the DaVinci Multimedia System at little or no cost.

New Art Basics - This project focuses the energies of a large group of K-12 art teachers and administrators, teacher education students, and university art education faculty on the collaborative task of designing and testing an innovative curriculum focused on developing subject-specific creative thinking skills in students. Currently, a body of more than 1300 carefully screened, teacher-designed, and classroom-tested learning activities are organized on the interactive computer data base called "The Living Curriculum".

The curriculum focuses on visualization, visual thinking, metaphoric thinking, visual logic and contextual thinking in human, cultural, and historical domains. It is conveyed to a statewide and national audience through an on-line interactive telecommunications network.

The Living Curriculum has the following features:

1. Instant searches of all project strategies by keyword, title, or number are possible. More than 200 descriptors allow any teacher to access sequential, age-appropriate teaching strategies. All files are downloadable by teachers for instant implementation of the newest teaching ideas.
2. There is an objectives file that is attached to each strategy. It lists applicable teacher-designed learning objectives, national visual arts standards, and state curriculum guidelines.
3. There is a testing file which is attached to each strategy. It is totally interactive for any teacher contacting the database. The database compiles teachers' experiences concerning the educational effectiveness of each strategy.

This project demonstrates how university faculty can be involved with school teachers in developing effective alternatives to static, textbook-driven curriculum models. The project has been evaluated by two independent and nationally-known art educators.

Each school district currently participating in the project owns an official share in the project. Iowa State University provides coordination and leadership for this teacher-owned and -operated project. The DaVinci Project Multimedia System materials will be made available through the New Art Basics network.

General Chemistry Network Project - This project involves faculty and students from four-year and community colleges within Iowa to develop and implement a new coordinated introductory chemistry curriculum. This curriculum will include instructional resources of a flexible, modular design that will serve the needs of diverse student populations and help to improve the compatibility between 2-year and 4-year programs.

Computer-based instructional modules are being developed. Modules will include interactive computer instruction that simulates concepts in chemistry, such as those in electrochemistry. In these modules three levels of representation are included—macroscopic, symbolic, and microscopic. Teachers or students can manipulate and interact with the lessons during lecture presentations, to supplement recitations, or in chemistry help centers and resource rooms.

The DaVinci Multimedia System materials will use and expand on many of the interactive materials produced by the Iowa General Chemistry Network Project, and will modify them for high school chemistry classes. At the conclusion of the project the DaVinci materials will be made available on-line through the Iowa General Chemistry Network.

SUPPORTING ORGANIZATIONS

College of Education

The mission of the College is to prepare professionals for teaching, research, service, and/or leadership roles in educational institutions, business and industry, and other agencies. Several areas have been identified by the College as areas of excellence. One is the use of educational technology, and a second is science education. The Curriculum and Instruction Department offers emphasis areas leading to the doctoral degree in both educational technology and science education, and has considerable experience in research and development in both areas.

The College is currently organized into four academic departments and four support units: Curriculum and Instruction (C&I), Industrial Education and Technology (IE&T), Health and Human Performance (H&HP), and Professional Studies in Education (PRST).

The Department of Curriculum and Instruction is the Department that will be involved heavily in this proposal. The department serves more than 1600 students in teacher education, and has more than 300 graduate students.

The College of Education is one of the strong Colleges that collectively make Iowa State University a broad-based university of international stature. The university's academic program, with an orientation toward science and technology and a strong emphasis on the humanities and the arts, offers the 25,000 students excellent opportunities for specialization across a broad spectrum of subject areas. Faculty members at ISU enjoy the support services expected of a large university. The library has more than 1.5 million volumes, an excellent reference department, an interlibrary loan agreement with other large public and private libraries, and a fully computerized reference search system.

Art and Design Department

The Department of Art and Design is integral to the College of Design at Iowa State University. The configuration of departments in the College of Design - Architecture, Landscape Architecture, Community and Regional Planning, and Art and Design - provides the college with a unique base found in only a few other colleges in the country. With about 45 faculty, the department is the largest in the college and offers majors in the fine arts, graphic design, interior design, crafts, visualization, and art education.

The art education program is well established in the department. It has been in place for 30 years. In the last three years it has become a graduate program only. All art education graduates are competent artists and are fully aware of the latest educational standards. One of the most significant activities of the department is the New Art Basics program. The Department is committed to interdisciplinary efforts and has a tradition of collaboration with other departments, colleges, and units both on and off campus.

Chemistry Department

The Chemistry Department in the College of Liberal Arts and Sciences is one of Iowa State University's largest and most outstanding. Faculty work closely with the U.S. Department of Energy's Ames Laboratory, located on campus. The department has 36 faculty and offers degrees at the B.S., M.S., and Ph.D. levels. Faculty teach courses in general chemistry to the ISU student body. Recently, innovative approaches to undergraduate chemistry education have been undertaken by the department. Chemistry faculty routinely collaborate with College of Education faculty in science education and instructional technology.

Interactive Courseware Development Laboratory

The Interactive Courseware Development Laboratory is a unit of Iowa State University's Media Resources Center. It is coordinated by David Graf. The lab has state of the art systems for courseware development, and staff have considerable experience in the development of multimedia materials in all disciplines, especially science and engineering.

Design Visualization Laboratory

Under the leadership of Professor Steven Hermstadt, students associated with the Visualization Laboratory have developed computer-based animations and artistic interpretations in a number of disciplines. Recent projects of the Lab include development of educational materials for the Ames Laboratory of the U.S. Department of Energy. A current

project with the physics department uses visualization techniques to communicate complex topics in physics.

Research Institute for Studies in Education

The Research Institute for Studies in Education (RISE) will conduct the project's needs assessment and evaluation activities. RISE is the research and evaluation center of the College of Education. It supports the research, evaluation, technology, and contracts and grants activities of College faculty, and serves as a independent agency for the evaluation of externally funded projects. RISE has a professional staff with expertise in research, needs assessment, evaluation, technology, and science education.

RISE staff have recently served as evaluators for the Iowa Distance Education Alliance, Iowa's $8 million U.S. Department of Education Star Schools project; the VISION 2020 Project, a comprehensive visioning activity of the ISU College of Agriculture funded by the W.K. Kellogg Foundation; the Experimental Projects for Women and Girls, funded by the National Science Foundation; and the Heartland Technology Network, a program to enhance technology application in small manufacturing firms in Iowa.

Schools

Teachers from five schools served on the DaVinci Project writing team and will continue to serve on the steering committee. Letters of support are included with this proposal.

Ankeny - Ankeny is one of Iowa's larger and growing communities located between Ames and Des Moines. The community population is 21,000, and the school enrolls 4600 students. Technology use is a priority for the Ankeny school district. Its schools are networked and teachers and students have access to the Internet.

Ames - Ames, home of Iowa State University, is a central Iowa city of approximately 46,000. The Ames Community School District has 5100 students. An average of 90 percent of its graduates enroll in colleges and universities, and the district has been recognized for its excellence. The chemistry and art departments are innovative ones that collaborate with other departments in the district and with other educational organizations. Computer-based activities are commonplace. The school is networked, and teachers and students have access to the Internet and other computer networks.

Des Moines - Des Moines is Iowa's largest city. It has a diverse population of 231, 000 with a variety of educational needs. The Des Moines School District has 30,000 students. It has collaborated with Iowa State University on a number of occasions, especially with the College of Education. Most teachers in Des Moines secondary schools have access to computer networks. Technology is a priority for the Des Moines school district.

Gilbert - Gilbert is located eight miles from Ames and is a small, suburban community of 800. It is the location of the Gilbert Community School District that serves 800 students from the surrounding area (district populaton of 2800). The district has been actively involved in innovative educational programs for several years, including a supercomputing project, the global schoolhouse initiative, and Iowa's Star Schools project. The district's schools are networked, and teachers and students have access to the Internet.

Story City - Story City is located about 20 miles northeast of Ames. The Roland-Story Community School District serves approximately 1100 students and is administered from this community of 5200. The district is in the process of networking classrooms so teachers and students have access to computer networks.

Women in Science and Engineering

The Program for Women in Science and Engineering (PWSE) at Iowa State University was started in 1986 with the mission of promoting women's and girls' participation in science, engineering, and mathematics. PWSE projects reach girls, educators, and parents at the K-12 level; women students, faculty, and staff at the university level; and professional women scientists and engineers. PWSE sponsors programs and collaborates with other organizations that have the potential to positively influence girls and women in science and math. The PWSE will assist the DaVinci scholars to develop materials of interest to women and girls.

EVALUATION PLAN

Evaluation will be a key component of the proposed project. The evaluation plan described below is organized according to (a) purpose of the evaluation, (b) key questions the evaluation will address, (c) methods used for the evaluation, and (d) information about the evaluators.

Purpose of the Evaluation. The evaluation plan is a decision-based model. Data gathered as part of the evaluation will not only provide summative information, but also will provide formative information to use for improvement throughout the project.

Key Questions. The evaluation model used for this project will address the following areas:

1. Accountability - assessing whether the project accomplished the activities outlined in the proposal and whether the activities were accomplished in a timely manner.
2. Effectiveness - assessing the effectiveness of both the activities conducted and of the implementation process.
3. Impact - assessing changes in attitudes, behaviors, and practices that occur as a result of the project.

Methods Used for the Evaluation. Qualitative and quantitative information will be collected. DaVinci scholars and others involved in the project will provide data throughout the project for evaluative purposes. In addition to the needs assessment discussed earlier, the following data will be collected.

1. Accountability: Documentation and reports will be requested quarterly from the project's principal investigators to assess completion of project activities as identified in the project goals, objectives, and activities.
2. Effectiveness: (a) The effectiveness of the multi-media packages will be assessed through a survey of users of the packages. Survey instruments will be developed for incorporation in the packages using both on-line and paper and pencil applications. These surveys will be completed by all users, including instructors and students. (b) The effectiveness of the training workshops will be evaluated through a survey of the participants. (c) The project participants, both DaVinci scholars and faculty members involved in the project, will be asked at three points (twice during year one and once during year two) to assess the effectiveness of the process using both Likert-scale and open-ended survey questions.
3. Impact: A focus group format will be used near the end of year two of the project to assist in determining the impact of the project from the perspectives of the participants. Focus groups will include DaVinci scholars and others involved in the project. Focus group participants will be asked to identify specific changes that have occurred as a result of their participation in the project, for example, changes in their attitudes toward chemistry and art instruction, and changes in classroom teaching

practices. The DaVinci scholars will also be asked to identify specific ways that they will implement the visualization materials in their curricula.

Evaluation Staff: Staff of the Research Institute for Studies in Education (RISE) of the College of Education at Iowa State University will participate in the evaluation process. Evaluation activities will be co-directed by Dr. Jan Sweeney and Dr. Chris Sorensen, both with considerable experience in the area of evaluation. Two recent evaluations conducted by Drs. Sweeney and Sorensen were (1) the evaluation of the Iowa Distance Education Alliance, a two-year $8 million project funded by the Star Schools Program of the U. S. Department of Education and (2) evaluation of the Heartland Technology Network, a project funded by the state of Iowa to promote technology transfer in manufacturing environments.

CONCLUSION

"One of the most important curricular areas that provides a foundation for critical, logical, and creative thinking is chemistry. This statement is also true, if when repeated verbatim, the word art is substituted for the word chemistry" (Waltz, 1992).

Certainly, the two disciplines are considered fundamentally different by the vast majority of students and scholars. While the DaVinci Project will not dispel this long-standing perception about the differences between art and chemistry, it will serve as a model, a prototype, for reform and change. The DaVinci Project will produce concrete, observable, and measurable products - long the goal of both artists and scientists - that will pay testimony to the project's purpose, the bridging of the artificial gulf between the worlds of the artist and the chemist.

On the far wall of the laboratory there is a note:

the measurement
is a poem
if properly expressed.

REFERENCES

Brain/Mind Bulletin Collections. (1985). The creative process. 10(12a), Los Angeles, CA: Brain/Mind Bulletin Collections.

Gabel, D. L., & Sherwood, R. R. (1984). Analyzing difficulties with mole-concept tasks by using familiar analogue tasks. Journal of Research in Science Teaching, 21, 843-851.

Gabel, D. L., Sherwood, R. D., & Enochs, L. (1984). Problem-solving skills of high school chemistry students. Journal of Research in High School Teaching, 21, 221-233.

Gentner, D. & Stevens, A. (1983). Mental models. Hillsdale, NJ: Lawrence Earlbaum Associates.

Herron, J. D. (1990). Research in chemical education: Results and directions. In Gardner, M., Greeno, J. G., Reif, F., Schoenfeld, A. H., Disessa, A., & Stage, E. (Eds.). Toward a scientific practice of science education. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Waltz, E. (1992). Linking bonds between art and chemistry. In R. Braden, (Ed.), Art Science and Visual Literacy: Selected Readings from the 24th Annual Conference of the International Visual Literacy Association.

BUDGET EXPLANATION

Personnel: The project's co-principal investigators will be assigned to this project for approximately 10% of their time. $2500 of their salaries and benefits ($2007 salary and $493 benefits) will be funded by U S West and the remaining amount will be contributed by Iowa State University.

A part-time (50%; $15290 salary and $4710 benefits) project manager will be hired to coordinate the day-to-day activities of the project. Additionally, two part-time (40%; $9375 salary and $625 benefits) research assistants will be assigned to work on the project--one in chemistry education and one in art education. A part-time (10%; $1434 salary and $566 benefits) secretary's time will be funded by U S West. Additional secretarial support will be contributed by Iowa State University.

Thirty DaVinci Scholars will be identified. Teachers will be supported at a rate of $100/day for the time they are work on the project during break-time workshops, week-end sessions, and summer activities. Teacher Education students will be supported at a rate of $25/day for their time commitment to the project.

Materials Development: These costs are for the production and duplication of the materials included as part of the DaVinci Multimedia System. Also requested from U S West are the costs for the production and duplication of materials used in the project's workshops, and for classroom pilot-testing of materials.

Travel: A minimum amount of travel support is requested at $.21/mile.

Supplies: Minimal office supply support is requested. This includes general office supplies, postage, and copying. Other office supplies, office equipment, and telephone/computer networking for use by project staff will be contributed by Iowa State University.

Equipment: DaVinci scholars will require a modem, high speed microcomputer in their classrooms for networking, materials development, and project demonstrations. During the first year of the project 10 computers will be purchased for the 10 DaVinci scholars with the greatest need. Participating schools will contribute approximately 1/4 of the cost of the necessary equipment and software. Networking support will be provided by the participating school at no charge to the project. During Year 2 of the project, the remaining 10 computer systems will be purchased also on a cost sharing basis. Teacher education students who serve as DaVinci scholars will have their computing needs supported by ISU.

Contractual: The Research Institute for Studies in Education will be contracted with to provide needs assessment and evaluation services. During the first year of the project the contract will include $3000 for needs assessment activities and $5000 for evaluation activities. During year two of the project the evaluation contract will be for $8000.

The Design Visualization Laboratory will provide visualization support during both years of the project ($9000 for Year 1, and $5000 for Year 2, and the Interactive Courseware Development laboratory contract will be for $5000 Year 1 and $9000 during Year 2). These contracts will provide personnel, consultation, equipment access, and production support to the DaVinci Project.

Indirect Costs: No indirect costs are requested. Iowa State University's standard indirect rate of 44% will be part of the University's cost share contribution to the project.

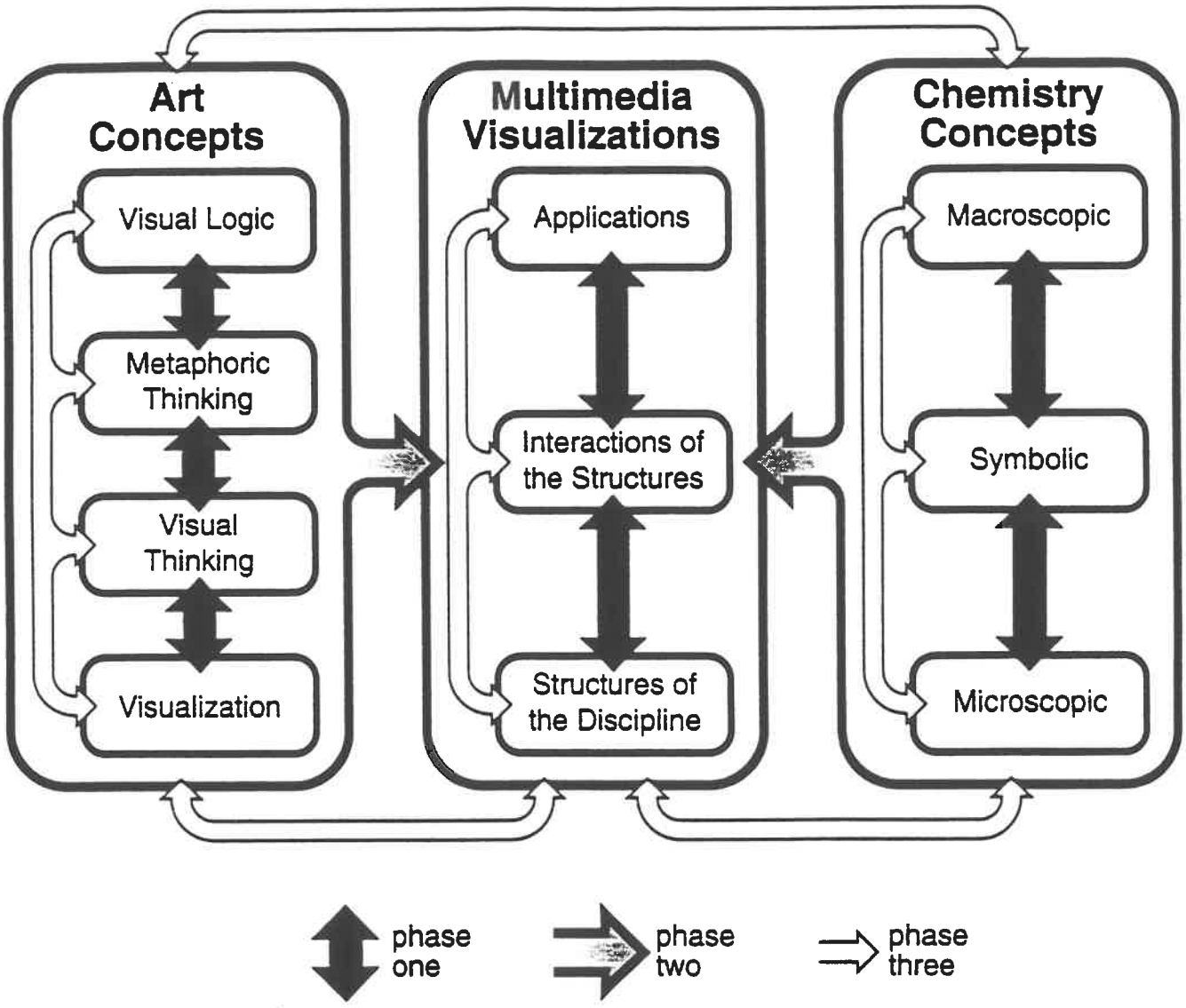

Figure 1. Concept Map - The DaVinci Multimedia System

DaVinci Project Budget

FUNDING PURPOSE	Year 1 1995-96 REQUESTED US WEST FUNDING	YOUR ORGANIZ. FUNDING	OTHER FUNDING SOURCES	TOTAL	Year 2 1996-97 REQUESTED US WEST FUNDING	YOUR ORGANIZ. FUNDING	OTHER FUNDING SOURCES	TOTAL
1 PERSONNEL								
Co-PIs - Salary + Fringe @24.55%								
Dennis Dake ($50,375/yr.)	$2,500	$3,774	$0	$6,274	$2,500	$3,774	$0	$6,274
Gary Downs ($60,963/yr.)	$2,500	$5,093	$0	$7,593	$2,500	$5,093	$0	$7,593
Tom Greenbowe ($52,100/yr.)	$2,500	$3,689	$0	$6,189	$2,500	$3,689	$0	$6,189
Mike Simonson ($72,585/yr.)	$2,500	$6,540	$0	$9,040	$2,500	$6,540	$0	$9,040
Project Manager (.5 FTE)								
Salary + Fringe @30.08%	$20,000	$0	$0	$20,000	$20,000	$0	$0	$20,000
DaVinci Scholars								
Art teachers	$15,000	$0	$0	$15,000	$15,000	$0	$0	$15,000
Chemistry teachers	$15,000	$0	$0	$15,000	$15,000	$0	$0	$15,000
Teacher Education students	$4,000	$0	$0	$4,000	$4,000	$0	$0	$4,000
Research Assistants (.4 FTE)								
2 @ $9,375/year + $625 Fringe	$20,000	$0	$0	$20,000	$20,000	$0	$0	$20,000
Robin Gogarty (.1 FTE)								
Salary ($16,722/yr.) + Fringe @ 39.45%	$2,000	$332	$0	$2,332	$2,000	$332	$0	$2,332
Total Personnel	***$86,000***	***$19,428***	***$0***	***$105,428***	***$86,000***	***$19,428***	***$0***	***$105,428***
2 MATERIALS DEVELOPMENT								
Multimedia lessons								
Production and duplication	$4,000	$0	$0	$4,000	$5,000	$0	$0	$5,000
Workshop materials								
Production and duplication	$4,000	$0	$0	$4,000	$5,000	$0	$0	$5,000
Classroom uses	$1,000	$0	$0	$1,000	$0	$0	$0	$0
Total Materials Costs	***$9,000***	***$0***	***$0***	***$9,000***	***$10,000***	***$0***	***$0***	***$10,000***
3 TRAVEL								
DaVinci Scholars	$2,000	$0	$0	$2,000	$840	$0	$0	$840
Project Staff	$2,000	$0	$0	$2,000	$2,000	$0	$0	$2,000
Total Travel	***$4,000***	***$0***	***$0***	***$4,000***	***$2,840***	***$0***	***$0***	***$2,840***

DaVinci Project Budget

FUNDING PURPOSE	Year 1 1995-96 REQUESTED US WEST FUNDING	YOUR ORGANIZ. FUNDING	OTHER FUNDING SOURCES	TOTAL	Year 2 1996-97 REQUESTED US WEST FUNDING	YOUR ORGANIZ. FUNDING	OTHER FUNDING SOURCES	TOTAL
4 SUPPLIES								
Materials	$500	$0	$0	$500	$500	$0	$0	$500
Total Supplies	***$500***	***$0***	***$0***	***$500***	***$500***	***$0***	***$0***	***$500***
5 EQUIPMENT								
Computers and related equipment	$28,000	$0	$10,000	$38,000	$28,000	$0	$10,000	$38,000
Networking	$0	$0	$5,000	$5,000	$0	$0	$5,000	$5,000
Total Equipment	***$28,000***	***$0***	***$15,000***	***$43,000***	***$28,000***	***$0***	***$15,000***	***$43,000***
6 CONTRACTUAL								
Research Institute for Studies in Education								
Needs Assessment	$3,000	$0	$0	$3,000	$0	$0	$0	$0
Evaluation	$5,000	$0	$0	$5,000	$8,000	$0	$0	$8,000
Design Visualization Center								
Visualization Development	$9,000	$0	$0	$9,000	$5,000	$0	$0	$5,000
Multimedia Laboratory								
Multimedia Lessons	$5,000	$0	$0	$5,000	$9,000	$0	$0	$9,000
Total Contractual	***$22,000***	***$0***	***$0***	***$22,000***	***$22,000***	***$0***	***$0***	***$22,000***
DIRECT COSTS	**$149,500**	**$19,428**	**$15,000**	**$183,928**	**$149,340**	**$19,428**	**$15,000**	**$183,768**
INDIRECT COSTS								
Grant TMDC x 44% (cost share)	$0	$53,460		$53,460	$0	$53,390		$53,390
ISU costs x 44%		$8,548		$8,548		$8,548		$8,548
SUBTOTAL	**$149,500**	**$81,436**	**$15,000**	**$245,936**	**$149,340**	**$81,366**	**$15,000**	**$245,706**
TOTAL PROJECT COST				**$491,642**				
TOTAL REQUESTED FROM US WEST FOUNDATION				**$298,840**	**60.78%**			

Figure 2: The DaVinci Project
Sequence of Events

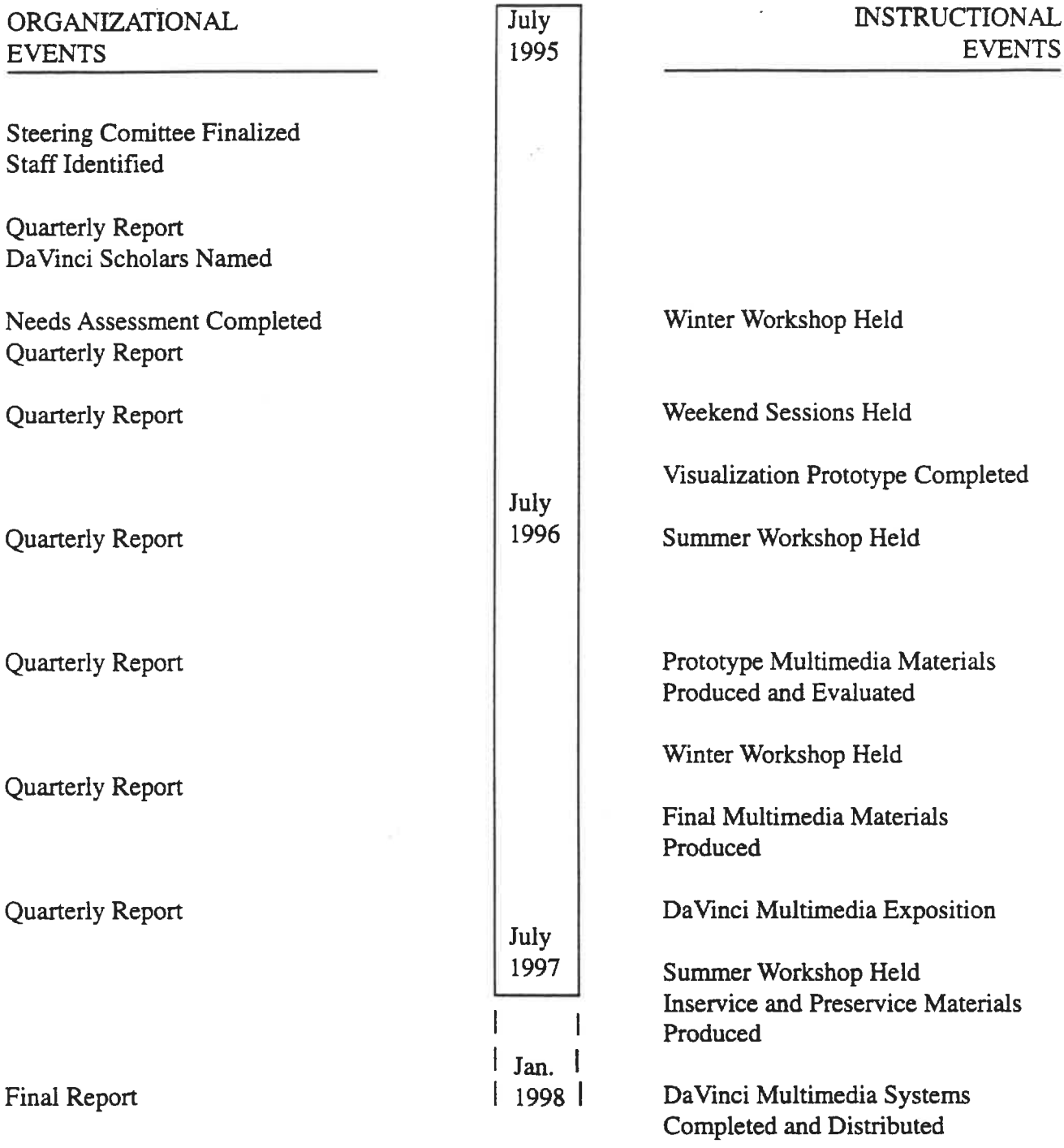

Figure 3 - DAVINCI PROJECT

ORGANIZATION PLAN