Computers in Design Education: a Case Study
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Abstract: This article is a condensed version of a larger study entitled *Design with Computers, Design for Computers. Computer for Design-Enhanced Creativity: Proposal for a Computer Implementation Model for a College of Art and Design.* The plan deals with all areas of education that the Rhode Island School of Design is responsible for: Freshman Foundation, Liberal Arts, the library, the museum, and first of all the degree programs in art, design, and architecture. For the purposes of this presentation, emphasis is placed on computers in relation to art and design. The plan covers the following aspects:
1) What computers can do for design;
2) What designers (and future designers) in the educational environment can do for computers and computer-aided technology.
The characteristics of the college and its relations with nearby colleges and businesses were carefully considered in light of the state of the art in computer technology and software.

The Challenge
The Rhode Island School of Design (RISD) can and should accept the challenges of post-industrial society because of its advantageous position as an institution highly regarded for past achievements. While faithful to its fundamental values, the School proved adaptable to new exigencies. This is the premise for the entire study. The proposal presents a model for implementing computers and computer-related means of expression, representation, and communication in an environment which, despite its potential, has received scant attention from the computer industry and computer scientists. The College, in its historical, cultural, geographical, and institutional context, is one of the best prepared entities for conceiving and implementing the proposed model, as the following arguments and presentation of directions to be explored will show.

Two issues should be at the core of our concern over the use and study of computers:
1. How will design be changed as a result of the post-industrial revolution, primarily through the extensive use of computers?
2. How will design change the world as it influences technology and human relations, especially in the environment of widespread computer-supported human activities?

Although the Rhode Island School of Design is not and will not become a high tech institution, it has to commit itself to considering the following issues:
• computer use in its various design, architecture, and art programs (Liberal Arts should not be excluded), as well as issues of present and future education in these fields;
• design for computers and their future improvement, especially in user interface, computer graphics, industrial design, and ergonomics;
• design and production of computers and computer-supported equipment in relation to various design activities, with special emphasis on graphic design, industrial design, architecture, and art applications.

Consequently, during the time this proposal will be pursued, the following will take place:

Computers and computer-supported technology will be progressively introduced in the main programs.

Computer-related student projects and graduate student research, as perceived from the perspective of design and art, will be encouraged.

Semiotics and HCI
An interdisciplinary entity to coordinate the work and interest of faculty, students, librarians, alumni, etc. regarding computer-related and external research will be established.

For the latter purpose, an Institute for the Semiotics of the Visual, which would coordinate the themes and projects addressed herein, has been considered on the basis of the positive results that semiotic research and instruction has already achieved. The increasing awareness of the role

of semiotics in communication (particularly visual communication) and interface has made the Institute a potential center for the elaboration of theory and its application. It would place RISD in the favorable position of being able to confront complex computer issues from a broader perspective. The fact is that interface (interaction among people or between people and machines) is conditioned by the actual human subject (as part of a community or as user of tools, designs, products) and limitations in hardware (tools and other devices people use) and software. This is a pragmatic issue that integrates the knowledge of formal structures (the syntax of design) and the awareness of content expression in art and design (semantic issues).

In a college such as RISD, the Institute would concentrate on:
communicational aspects of computer-aided instruction in the environment of an art and design college, insisting on an adequate liberal arts education; the semiotic aspects of man-machine relations, i.e., user interface problems; new applications of computers in art and design and the development of conceptual knowledge of such applications; and criteria for evaluating CAD.

Community and industry involvement

This proposal implies that the support of manufacturers, business, and federal institutions established to aid initiative and innovation in education, design, architecture, art, and science will be granted due to the merit of the endeavor and to the impact that computer design will have on future social and cultural developments. Technology can serve as a support for the development of the ideals and values of the human beings for whose sake technology is conceived and produced. This is why Liberal Arts education should pay attention to complex social, cultural, and philosophical issues involved in work with computers.

The model proposed will make computers accessible to everyone in the School while respecting the alternatives of using computers in only some creative work, in part of a creative work, or not at all. In relation to the RISD community at large, the intention is to progressively introduce electronic mail, documentation services, and information storage and retrieval on the campus, to connect with similar functions at Brown University and, through teletext/videotex, to make an opening to the larger community. Continuing education courses via computer-supported communication channels will be offered, assuming that interactivity can be satisfactorily maintained.

Library and museum

The Library and Museum are fundamental parts of RISD. In the first case, a new concept of a computer-supported library will have to be developed, adapted to the reality of *a library in which text and image form a unit and in which visual documentation becomes a design tool.*

In the case of the RISD Museum, storage and computer-aided retrieval, probably on videodisc, can lead to a *memory* of exhibits and events that can be used for educational, cultural, archival, and other purposes and also be accessible to the public. It is essential for the Library and Museum to have systems for hard copy, slides, photographs, films, and videotapes of high resolution and acceptable quality and retrieval capability. This is why potential support from the computer community and from other industries (photography, film, video, etc.) interested in adapting products to new market demands must be considered.

Creativity with computers

Future artists and designers, who will serve in various capacities in many activities, should get the best chance to use computers creatively. This entails more than computer literacy. Creativity is facilitated by the general context of education and is tested through the independent activity that RISD encourages. Creativity is vital to the computer industry, as well as to all industries and businesses that use or will use computers.

Post-industrial society is characterized by the transition from labor intensive to information-controlled production. Increasingly, mediating activities determine the shape of our present and future, the main *mediator* today being the computer. In order to deal with complex issues deriving from this reality, several faculty members and students have carried on research in semiotics focused mainly on visual mediation through computer graphics, integrated communications networks, user interface, and image processing. Changes will arise in the status of work, of the producer, of criticism and evaluation, of marketability, and of the representational nature of art and design in culture.

Introducing computers

Our focus is on the application of the computer as a medium for art and design. Pedagogical and financial considerations dictate that this application must progressively develop from its present, almost non-existent scale to the point where it becomes generally available. The cost of hardware, software, and maintenance that fit the needs is indeed high, but RISD should carefully consider the consequences of not offering new technology to students.

First of all, because these devices are so complex, time is required for their assimilation into instructional activities and for training faculty members and students. A major consideration is instructor time. Due to the complexity of the issue, the application of the computer as a design medium will not streamline design teaching at the very beginning. No one can foresee how each particular program will (or will not) use computers. The strategy is to proceed step by step inside and outside the educational environment, to learn by doing, exactly the way students are educated in art and design. Once the faculty becomes acquainted with the aspects of CAI, its evaluation and criticism of products and projects, which belong to unprecedented aesthetic activity, will be central to the curriculum.

Accordingly, the program will initially be limited in scope, the number of students able and willing to take part being the most important factor. Below is a proposed priority system for student participation should consider the following items:

Students in departments where familiarity with computer-aided design (CAD) is fast becoming a professional requirement

Students for whom computer art or design will be a study concentration

Students who will choose to use computers in producing their projects.

These students will work in their respective programs under the auspices of their advisors and the Institute. They will be able, with the computer, to carry out studies of form regarding the limitations of the glass medium, for example, which can be demonstrated on a high-resolution color screen. Multi-perspective, computer-aided photography devices, scanning, and digitizing can help photography students and teachers. (Availability may have to be limited to upper class and graduate students at the outset.) In all divisions it will be possible to approach the individual and custom tailor education on criteria that relate to the individual's strengths and weaknesses. In a college like RISD, this is a legitimate expectation.

Cooperation with industry

The School's mission is to provide the best educated artists and designers at the time and for our time. It can help hardware and software researchers, manufacturers, engineers, etc. to improve their products. Hardware and software are produced by people who deal mainly with technological aspects, unaware of or disregarding design, communication, aesthetics, and other aspects of user interface. The users, be they designers, educators, librarians or others, are left to face a complex device, unprecedented in the history, that manufacturers hand down more often than not under market pressure and before sufficient research on user interface and other important aspects (ergonomic, social, cultural, etc.) is carried out. But in order to contribute design ideas and sensibilities, designers and artists need experience with computers in order to be in a position to evaluate them from the perspective of their professional requirements.

The implementation model described here thus becomes part of an evaluation procedure that should interest a large segment of industry. Support from those segments of the business community looking for computer-trained artists and designers will influence RISD's preferences. It will respond to the demands of industry and business in respect to education and expect in turn their support and contributions to RISD's endeavor to integrate and improve digital technology. The Institute will oversee the integration of demands and responses in order that the expectations of the School and of industry are responsibly met in curricula and research.

Design with Computers

During the two years of its activity, the Computer Literacy Committee made several recommendations. Educational access and experience with computers should be acquired as soon as possible. In order to avoid duplication of effort and to minimize cost, a computer program at RISD should be school-wide, not limited to one department and independent of others. The program should stress art and design education applications rather than programming or computer science studies. The program should begin with microcomputer- and computer-aided communication systems. Cost, plus the fact that applicable software is readily available, plays an important role in this decision. Microcomputers could later serve as *intelligent* terminals in a future network to be gradually set up and supported by a mainframe computer. Furthermore, the experience that the School would gain in the first two years of this implementation model would help in later use of more powerful computers and in taking the initiative in RISD's field of expertise. Within the four-phase framework proposed by the Computer Literacy Committee, "… the Design and Architecture Divisions will simultaneously pursue a number of applications suggested in this plan. The goals set forth herein cannot be realized if some applications are neglected. Lower level applications must provide a foundation for higher level applications; and the latter must facilitate improvement of the former.

Initial applications of the program would be directed towards design, the area where interest and aptitude are most demonstrable, and where computer skills are fast becoming a professional requirement. From this beginning, the program would spread by chain reaction. The art programs, for example, would prepare for computer use by being exposed to recent works and new techniques, by experimenting with smaller units, and evaluating currently available PAINT programs. This would set the foundation for total integration within eight to ten years. Initial application also consists of using microcomputers for structural analysis and technical enhancement of student work in architecture and industrial design, and computer-supported typesetting and other means of electronic publication in graphic design.

For the first application, students will be introduced to simple programming as an alternative to conventional mathematics. This offers several advantages. By writing simple programs, students are freed from mechanical aspects of conventional mathematics. They will have immediate visual confirmation of their calculations (conventional mathematics offers no confirmation). By realizing the relationship between program and visual output, students should gain insights into *visual thinking*.

Another important advantage is that, once written, these programs can be applied to a group of problems. At present, structural analysis is time consuming, and students tend to guess when working on a project. Similarly, the microcomputer's word processing capabilities should make it possible for students to realistically and comprehensively document their projects. Documentation is now so time consuming that it frequently becomes functionally impossible.

Computer use should encourage better argumentation from the students and a broader basis for criticism by students and faculty. Computer-supported graphic design applications should help in the transition from Gutenberg-based technology to electronic devices.

The next step in computer implementation will be to teach basic elements of competency in CAD for the job market. While one of the distinguishing aspects of RISD is that design skills take precedence over technical skills, proficiency in the latter is nevertheless a basic requirement of all design departments. CAD skills are becoming akin to drafting, photographing, and model-making skills that students now commonly use to produce their projects. Today, computer skills are in demand because of their scarcity. In the future, they will be a basic requirement for employment in most design professions. It is therefore important that most design students be exposed to the computer while still in college. Furthermore, this stage will serve as an introduction to higher level applications.

Higher level application deals with the computer as a complex design tool. Here the emphasis is on design and artistic quality rather than on technical aspects. Familiarity with the computer's capabilities are a prerequisite because it is only through application as a design tool that a student gains understanding of how the tool is simultaneously a design medium. True CAD will come about only when designers are able to think in the language specific to computers, within its possibilities and restrictions. Students and faculty can experiment on a visual level with the goal

of *integrating human factors and aesthetic values* into computer design.

Design for Computers

Computer technology promises to change the nature of design and to participate in the establishment of new forms of graphic expression. Past design problems dealt with specific information and could be solved by a craft-oriented approach, which cannot lead to the complex visual systems necessary for conveying the non-finite, non-sequential information that the computer is capable of conveying. It is only through experimenting with the appropriate medium that a new, more objective form of design can be developed, and the medium itself improved. Experimentation will also lead to better understanding of the role of the designer in an environment in which the visual will play an increasing role.

A continuation of higher level application involves research. RISD has carried out research in the past and is qualified to do so for visual and design aspects of computer technology. RISD faculty and students are qualified to pursue the following directions:

Development of visual standards for electronic communications. At present, several faculty members are negotiating such research in videotex

Development of the computer as an ergonomic research tool. For this, RISD should seek to work with a university or company with programming capabilities. This research could lead, for example, to applying the computer as an aid in dimensioning industrial and architectural designs to more closely agree with human standards, to applying the computer in understanding the body's tool-using capabilities in respect to industrial design and design for the handicapped. (The last application acquires priority in view of its significance to society)

Design of hardware packaging for future/potential technologies in computer-related fields and design of ergonomic input devices

Research on input/output devices and user interface from the perspective of visible language, with emphasis on making the computer more responsive

Research on training and education of art and design users of computer systems from a design perspective

Digitizing techniques, anti-aliasing procedures

Hard-copy procedures

Non-CRT dynamic image display

Image processing, interactivity, establishment of parameters

The list is not exhaustive and does not represent an order of priorities. It is subject to what is possible and necessary and to the students' and faculty's fields of interest.

Design is a discipline that reconciles human issues with technology, that mediates between the user and the technology used. As an art and design school, RISD can contribute to the development of the computer as it relates to people. Since nearly all computers are intended for human interface, design is very much a computer concern. RISD will seek to set standards for the computer as a design medium. Videotex, teletext, and electronic publishing lack the graphic quality of traditional media. Iconic interface has proved effective, but there are few guidelines for producing effective icons and for articulating a visual language as an effective user interface. RISD students and faculty can offer constructive criticism of computer graphics and CAD/CADAM systems from a design viewpoint. Through the Institute for the Semiotics of the Visual, it can offer an interdisciplinary perspective so lacking in the development of new computer systems. Students and faculty will apply the medium to areas overlooked by technicians, while demanding that new products be introduced. The possibilities RISD offers to the computer industry are as unlimited as the imaginations of the students, faculty, and (even) administration.

Many paths to social innovation have been opened by the responsible use of new technology. Substantive changes are the result of more efficient data-processing techniques usually associated with the fourth generation of computers. New problems arise and new tools are invented to cope with them. However, strengthening a particular technological model does not contribute to its validity.

If activities that made no sense before computers are now transferred to computers, they will still not make sense. This leads to the question: When are computers justified and what makes them

necessary in a particular field of human activity? It is known that computers can easily become mass generators of tasteless products, of objects repugnant to aesthetic value. The computer is not to blame for the ease with which it reproduces bad taste. The human subject who programs such products and affects public perception of value through an aesthetic *dumping* facility is at fault. To prevent misuse is a utopic ideal. Computers cannot be built to be *guardian angels* of aesthetic and social values. What can be affected is the education of the user, the one who influences the quality of the products the public expects from machines.

If the technical performance of computers is compared to their design, the discrepancy between the two is obvious. Stereotype design condemns computers to a limited potential. Introducing computers in art and design education is the necessary step towards a new form of applied design meant to improve the way they relate to what they do and to their users. *Improvement of the computer and its software cannot come about without the involvement of artists and designers.*

Computers for Design

An important topic is the role design plays and will play in the future of society. People have to understand that, due to complex changes in the way they think and act in the post-industrial age, the designer will have an increasingly active role, will be a source of new ideas and concepts related to the way people live, work, and approach their environment. In order to fulfill these expectations, designers have to be able to produce and experiment with as many ideas as possible and to use the new tools that technology places at their disposal in order to present valid proof of the ideas they uphold.

The computer is considered a problem-solving tool. For the first time since tools were introduced in human pragmatics, one tool, one piece of hardware can adapt to and support numerous and very different activities. And because the computer can do this, it can lead people to redefine the main values in the civilization of which it is a component.

It is frequently said that computers enhance human capabilities and creativity. Actually, the computer allows for *diversity* because its main functions rely on the logic of permutations. In discussing diversity, the relation between problems, problem solving, and problem generating cannot be avoided. While designing, the designer effects changes in the world.

Designing is a complex activity that entails a responsibility extending from present to future, from one generation to another. The computer cannot guarantee the better. But it can be the tool that helps the designer evaluate alternatives. Before making a final decision, the designer has to deal with several models. In some design activities (architecture, industrial design, illustration, graphic design), alternatives are essential. Solutions are time-consuming in a field where time is an expensive commodity. The computer is the best medium for alternative studies and more and better contextual analyses. It frees the designer from banal activities, from everything that is not directly creative, and encourages the designer to consider as many options as possible.

Equally important at RISD is swift and easy access to visual source material from books, periodicals, and extensive clipping files. In a school of art and design, the library is an integral part of education. It provides access to writings essential for opening new horizons to future artists and designers.

New technology offers the potential for better access to these resources, for expanding library capabilities (especially through videotex and teletext). However, none of the systems currently available provides the variety of documentary sources that RISD Library offers to students, faculty, and others. This variety is countered by the problem of storage. A videodisc system can store vast amounts of information; its image storage is of high quality; retrieval is swift; and the permanence of videodisc storage is well suited to library use. The system also offers the distinct advantages of easier access to reference material, simultaneous referencing of material, and elimination of cross-referencing. The system is space efficient and practically immune to theft and damage. (Both of these factors pose a growing threat to library collections). Reshelving and inventory could almost be eliminated.

There are, however, difficulties in computerizing the RISD Library. A computer network with a video interface is necessary. In order to provide wide access, there must be an adequate number of terminals. For display of artwork, high-resolution color terminals are required. Data storage and retrieval programs would have to be reasonably sophisticated and adaptable to the needs of an art school. The issue of *electronic perusal* as opposed to reading is taken into account. Librarians and the Institute for the Semiotics of the Visual will find out under which circumstances such reading behavior occurs.

The largest problems by far are a time commitment of several years and the work required to create a database. Because of this, an electronic reference tool would at first only supplement the existing Library. (This proposal does not foresee a terminal library, but a more complex environment in which traditional values connected to the book are preserved while others, not possible in the *Gutenberg Galaxy*, are made possible.) Because the database of an electronic reference system can be accessed by a great number of users at once, RISD will be able to share its database with other universities and libraries, and, through home computers, with the general public.

For instruction, RISD wants programs that will sharpen analytical and critical skills and that are consistent with the way people think, i.e., heuristic programs with a high degree of interactivity (LOGO, for example). Existing successful programs will be used to teach students concepts and factual material in degree programs and Liberal Arts. Faculty and students must provide their input at each phase of development of software for instruction in art and design.

CAI offers several advantages. If the program is interactive and students see direct visual confirmation of their reasoning, they have more opportunity for involvement and are likely to learn more. Learning is self-paced. Instructors freed from the stereotypical aspects of instruction and evaluation so they can apply their competence to the creative aspects of teaching and to the student's creativity. Engineering problems (in architecture and industrial design), perspective, basic theories of color (in Freshman Foundation and the fine arts) are among many areas where CAI serves an important purpose.

A main issue in the approach set forth here is interaction among students. Since art and design are becoming a matter of interrelationships and inter-influences, it follows that these dynamic qualities are encouraged and that students should be trained accordingly. This interaction will at first be limited to physically co-present persons. In the future, distance should not be a major factor in learning. Interactive editing, among other things, will provide teachers and students, regardless of where they are, with the necessary instruments for sharing information at each level of work.

New modes of activity

The multi-modal system represented by the generic medium computer will fundamentally change not only the designer's and artist's work, but also the perception and pragmatics of art and design. These changes will affect the entire system of values participating in what is known as culture. It would be shortsighted not to deal with the pragmatics of art and design in the framework of a civilization in which the computer will play an important role. It is not within the scope of this proposal to present theoretical models that describe future societies based solely on technology. But it is certain that technology will be a source of new forms of aesthetic expression, of quite unusual perceptive modes, and unprecedented social evaluation procedures.

Considering the entire evolution of the human-machine relationship, one can say that designers have always suggested ways of adapting tools to users. What is today called computer graphics is the visual representation of very complex problems and data. Computer graphics, when removed from the context of design, becomes a technical problem; the very character of visual language is lost. Involving designers in designing new computing units, new microchips, new large integrated circuits means to allow, from the beginning, for better visual quality.

To allow for better visual quality means to allow for a higher degree of intelligence. The great competition in the current computer market is for higher intelligence. Until now, computers have proven to be marvelous instruments in approaching syntactic problems, that is, problems related to the way different *signs* (mathematical, technical, graphic) are put together. The next generation of computers will have to approach semantic problems, in other words, the relation between how

something is represented and what is represented. It is at this moment that the designer intervenes and ensures that those inner relations characteristic of the visual image are taken into consideration and adapted to the use of the machine participating in complex human activity.