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Teachers College, Columbia University
525 West 120th Street
New York, New York 10027

Institute for Learning Technologies

The Cumulative Curriculum Project

1) The Cumulative Curriculum Project at Teachers College could be an appropriate experimental application for field-testing the ACORN network, starting late in 1992, continuing for five or more years. Teachers College is working with the Dalton School, selected public schools in the City, and IBM Research to develop a multi-media based system of education. Preliminary development work will begin September 1991 and last several years. Very limited field-testing will begin in 1992-93 with much more extensive field-testing planned for further stages of the project. We should be ready to begin work on interfacing to Teranet in September 1992.

2) Components of the project that will interface with the ACORN Project would consist of IBM PS/2 Model 95's or IBM RS6000's, acting as servers for multimedia workstations, located in 50 Thorndike between Broadway and Amsterdam and 120th and 121st streets. A conduit under 120th street to Teachers College exists near Amsterdam Avenue and fiber can then be run in the basements of the Teachers College buildings to 50 Thorndike with relative ease. The development installation will initially consist of 1 or 2 servers and about a dozen workstations. They will be running either DOS 5.0/Windows 3.0 or OS/2 2.0.

3) During its initial stages, the projects connectivity requirements would be largely contained within its development suite with traffic requirements normally being low except for periodic simulations of full-scale use of the target design. As we move into field-test stages, each site will be self-contained and as it grows to the scale of a full school, in will generate traffic requirements approaching, at peak, 1 Gbits/sec. While the interconnection of various field-test sites is not essential, it would be desirable and is a requirement if the project shifts from the R&D exploration of feasibility to full implementation.

   While the mandate of the Cumulative Curriculum Project concerns education K-12, intellectually the multi-media resources and pedagogy we will be developing should be useful in many components of undergraduate education. We will be seeking funding to explore these possibilities. If we get such funds, we will need to connect to classrooms on the main campus as well as locations in key Columbia libraries.

Explanation:

The Cumulative Curriculum Project is an effort to develop a curriculum for K-12 education that makes intensive use of networked multi-media resources. With these resources, all intellectual contents and pedagogical resources can be accessible to all students and teachers at all times. As a result, the existing sharp demarcations between subject-matter areas and between grade levels can be diminished significantly. Students will be able to study a curriculum of improved scope and quality, setting their own pace and following their interests. We embark on the project in the belief that such a curriculum is now becoming technically feasible and that it will prove substantially more effective than the traditional print-based curriculum has been.

Four distinct components will combine to make the Cumulative Curriculum:

1) an extensive multi-media ***library*** of intellectual resources describing the natural and cultural universes;
2) computer encapsulations of the major intellectual strategies for explaining and interpreting phenomena -- in essence, the major ***disciplines*** of inquiry;
3) a repertoire of ***assignments***, appropriate to different ages and centering on different domains, that students will work on, using the computer-based disciplines and materials from the multi-media library; and
4) orientation and ***assessment resources*** that will help students -- not to mention teachers, parents, employers, and the public -- evaluate what they have accomplished, diagnose significant difficulties, and plan ensuing stages of study.

During 1990-91, a prototype, ***Archaeotype***, exemplifying the first three components, has been introducing Dalton School sixth-graders to ancient history through group excavations of a hypothetical site near Corinth, Greece. The ***Library*** consists of the materials from the ***Perseus Project***, a videodisc and CD-ROM on ancient Greek culture developed at Harvard, as well as graphic and text materials digitized by Dalton faculty members, available through an appropriately equipped Mac II. The ***Discipline*** is archaeology, with its basic procedures, tools, and intellectual strategies for excavating and interpreting a site, encapsulated through a program written in ***Supercard*** running on four Mac SE's. The ***Assignment*** consists of a hypothetical ancient site, designed by archaeologists, that a class of sixteen students spend twelve weeks excavating and interpreting. The site spans the major periods of ancient Greek history and requires students to interpret the major confluence of forces that shaped Greek experience. Students work in four teams of four on separate quadrants of the site and they must pool their findings and interpretations to make

sense of the whole site. This format promotes cooperative learning among the students.

In moving beyond this prototype, the Cumulative Curriculum Project will

1) greatly expand the scope and variety of materials in the multi-media Library,
2) systematize and extend the disciplinary tools available to groups of students,
3) build a full repertoire of assignments that will draw students into constructive engagement with all aspects of their physical and cultural surroundings, and
4) develop appropriate tools of assessment, diagnosis, and orientation.

Development work on the Cumulative Curriculum will begin at the Dalton School and Teachers College over the next two years, supported through a $2,000,000 gift to Dalton from a private donor and with a major corporate grant of funds, equipment, and technical assistance. We are still negotiating for the corporate funding and when it becomes available will influence the pace at which initial development work proceeds. The start and direction of the effort, however, is not contingent on the corporate funding and it will last a minimum of two years. If the idea proves effective, we expect to be able to sustain the effort at the level of $1 to $3 million per year, as an ongoing program of curriculum development and teacher education.

Initially, the Cumulative Curriculum will have three systems components, which are illustrated in Diagrams 1 and 2 --

1) a highspeed library network with several multi-media servers;
2) small-group workstations and teacher workstations which will be the locus of multi-media work; and
3) individual notebook computers for each student which will be linked to the system by wireless LAN.

During 1991-92 we will begin work on all four intellectual components of the Cumulative Curriculum and the first two systems camponents. This work will take place in 50 Thorndike between Broadway and Amsterdam and 120th and 121st streets. A conduit under 120th street to Teachers College exists near Amsterdam Avenue and fiber can then be run in the basements of the Teachers College buildings to 50 Thorndike with relative ease. Development machines will be IBM PS/2 Model 95's and Model 80's, with 4 to 16 megs of memory and appropriate multi-media boards, possibly with RS6000's as servers.

We expect the small-group workstation to be a major focus of the pedagogy associated with the Cumulative Curriculum, enabling the ex-

ploratory, cooperative learning that should characterize a fully computer-based educational system. These small-group workstations will serve, on average, four students each. Thus, a school of 1200 students would need approximately 300 small-group workstations, roughly 60 teacher workstations assuming a student-teacher ratio of 20 to 1, and some 1200 notebook computers. The network servicing such an environment would usually be sending different streams of compressed video, text, graphics or audio to each small-group and teachers workstation at any time. At video quality approximating VHS and effective compression of about 40:1, the data flow for video and audio for each workstation would be 2 to 5 Mbits/sec., with the aggregate load on the network possibly exceeding 1 Gbits/sec. at those times when most users were simultaneously drawing heavily on video and audio. For many educational uses, HDTV quality, were it available, would be intellectually desirable, and it would increase the potential data flow per workstation to over 100 Mbits/sec.

With respect to the ACORN Project, work on the ***Library*** and the library network system will be most important component. Our idea with the ***Library*** is to avoid the expense of acquiring exclusive rights to the multi-media resources, but rather to buy discs -- videodisc, CD-ROM, CD-I, Compact-Audio, what-have-you -- on the market just as libraries buy books on the market. We will index, store, and retrieve materials on these discs in their native format. When a user calls for an item, the library system will digitize it as necessary, compress it in real time if necessary, and then send it to the caller whose system will decompress it. In order to provide multi-media materials to a substantial group of users, the library will need multiple retrieval channels. One text-retrieval channel can probably serve many, perhaps all, users at a time; each graphics-retrieval and audio-retrieval channel will probably serve several, but not all, users at a time; and each video-retrieval channel will probably serve only one user at a time. A major task will be to figure out how many retrieval channels we will need in what combination and then to engineer the indexing and control system for them. Diagram 3 gives a general schematic of the Library.

We estimate that design and initial implementation of the ***Library*** will take two years. At the end of this time, we would like to be able to attach the Library Manager and its Servers to Teranet, each through an NIU, and to connect a prototype Student Study Suite consisting of 10 to 20 PS/2's to Teranet through a concentrator and a single NIU. In 1992-93 we plan to set up two field-test sites, one at the Dalton School at 89th Street off Park and one at P.S. 92 at 135th Street off St. Nicholas. These installations will be self-contained and need not be connected to the one at Teachers College. They will start with about 30 machines and will grow at increments of 12 to 24 machines annually if ensuing stages of the project receive funding. The installation at Teachers College will add a

teacher education function starting in 1992-93 which would increase the number of machines there by 12 or more annually for several years, depending on the scale of field-testing we were servicing. The traffic requirements are difficult to predict as they will vary greatly on the mix of video, text, graphics, and audio that real users select. In general we are designing for relatively self-contained school-wide networks providing separate streams of multi-media data to about 350 workstations.

Need for Teranet: Strictly speaking, the Cumulative Curriculum Project is not dependent on Teranet as an enabling technology, at least until we start trying to implement HDTV quality multi-media. Nevertheless, Teranet would be a powerfully facilitating technology for this project. The fundamental goal is to adapt the technology to serve educational and intellectual activities, not to adapt the educational and intellectual activities to conform to technical constraints. Without Teranet, network limitations will be an intrusive consideration requiring from time to time that the educational context be distorted to account for the limits of other network technologies. Teranet will not make all technical limitations disappear, but those associated with network throughput capacity will cease to be significant. This would be a major advantage in an effort to make full use of networked multi-media as the basis for a new educational system.

Benefit to Teranet: The Cumulative Curriculum Project points the way to a major implementation of multi-media computing, providing a large-scale context for the implementation of Teranet. Against a time horizon of 4 or more generations, it is quite conceivable that the locus of education will migrate from the school back into the home and workplace. Against a time horizon of 1 to 2 generations, however, that is very unlikely as schools serve a complex of functions beyond the educational that will not quickly migrate to home "edutainment" centers or the like. Schools socialize, usuolly for better, sometimes for worse. Schools pravide day care and help families cope with the constraints of work and managing mobile lives. Schools serve as community institutions, intermediate between large bureaucracies and isolated, inward-looking homes, providing civic shape, hope, and meaning. Schools should be restructured, not displaced. The Cumulative Curriculum Project aims at such restructuring of the schools and if successful, it would provide Teranet with a very substantial domain for implementation. There are some 100,000 schools nation-wide that spend some $150 billion annually, several times that many around the world, spending over $1 trillion annually. Schools are a domain through which we can develop and support technologies that enhance the quality of life.

Diagram 1

TC Cumulative Curriculum Project
Generalized schematic of **Student Study Suite**

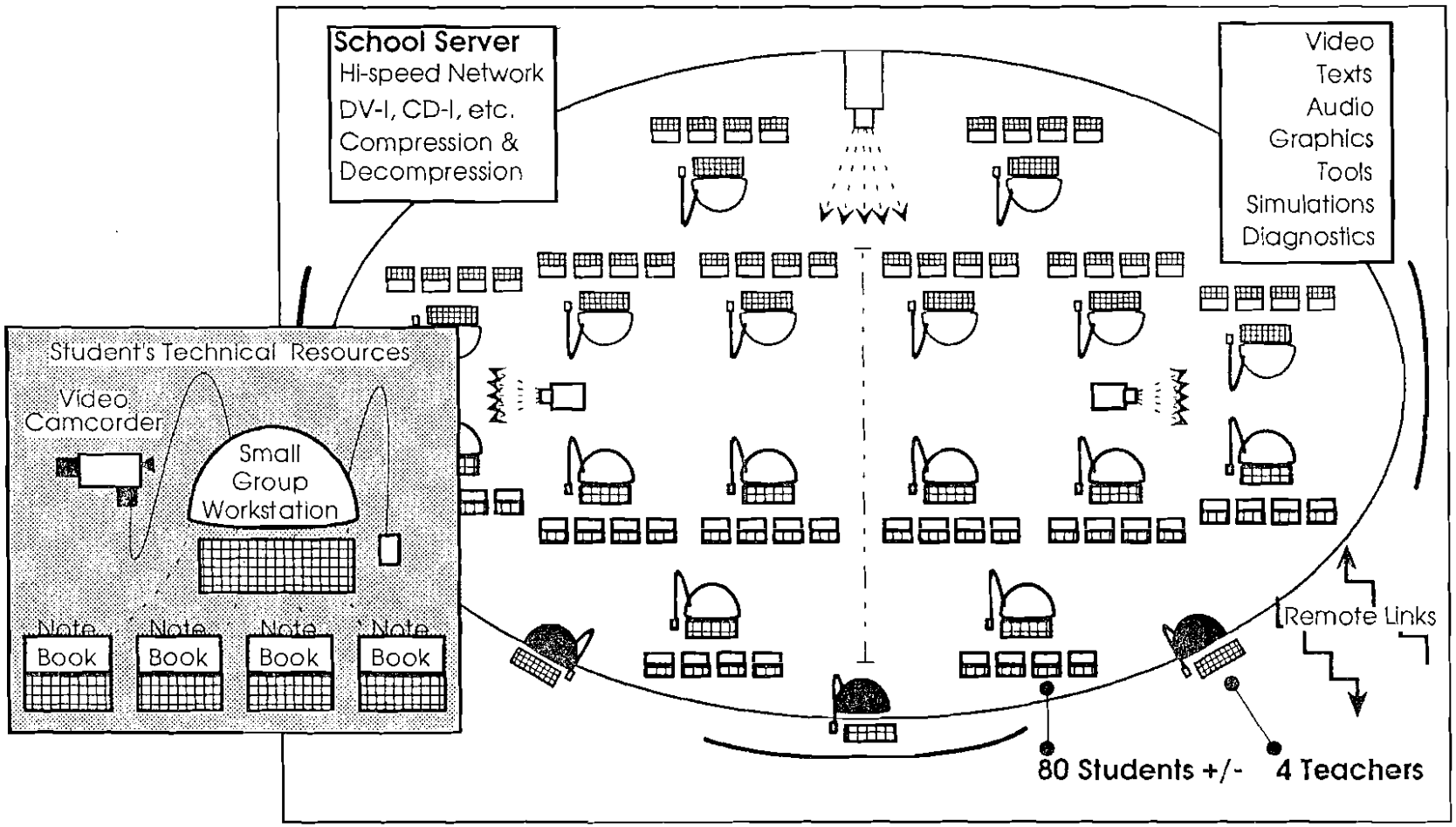

Diagram 2

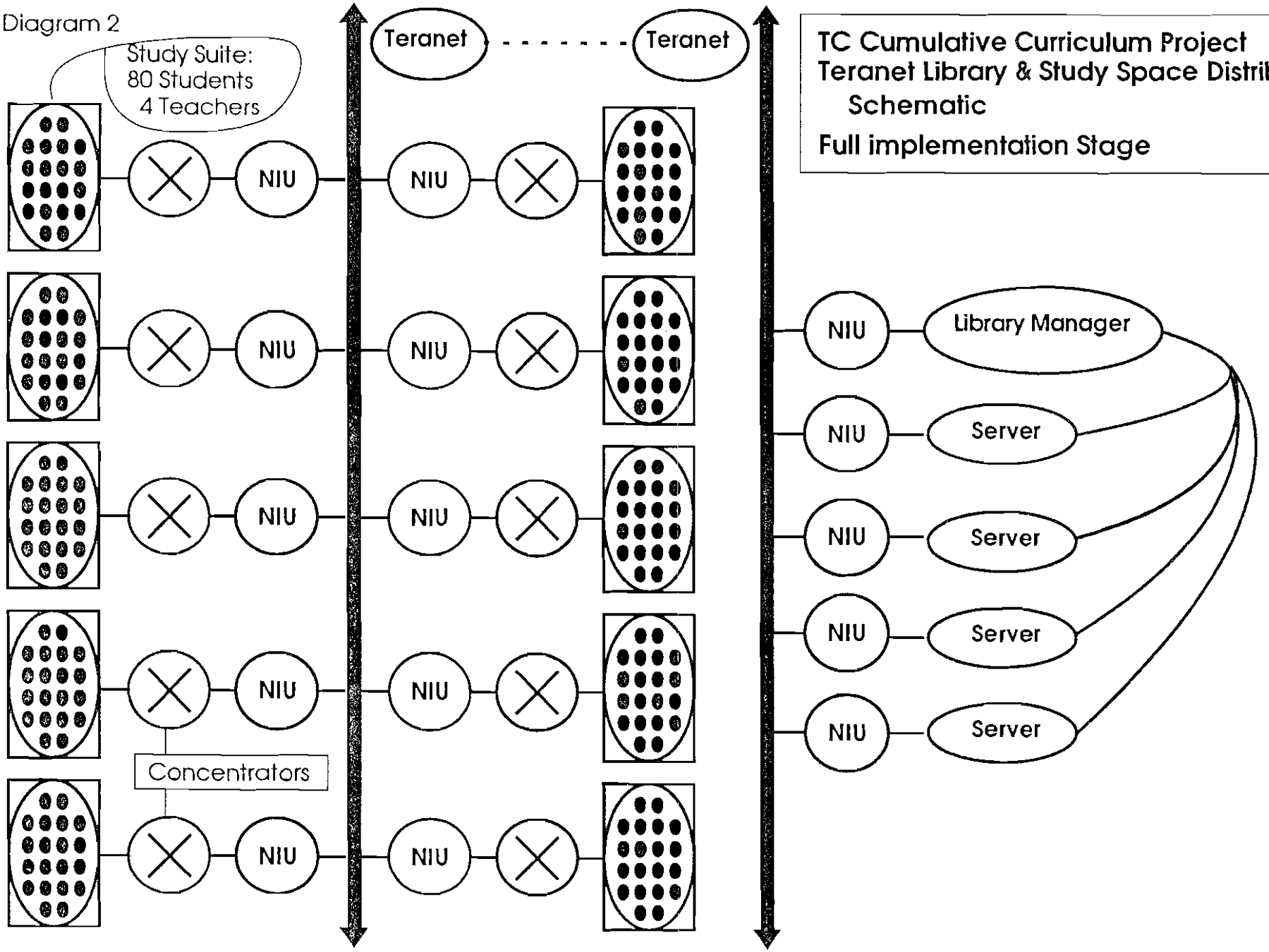
Study Suite:
80 Students
4 Teachers
Teranet
Teranet
NIU
Concentrators
TC Cumulative Curriculum Project
Teranet Library & Study Space Distribution
Schematic
Full implementation Stage
Library Manager
Server
Server
Server
Server

Diagram 3

TC Cumulative Curriculum Project -- Library Schematic

Number of NIU's to be determined