CDEC Productivity Brief

Preston K. Covey, Director
Vice Provost for University Studies

October 20, 1987
Contents

CDEC Mission & Strategy ................................................................. p. 3
CDEC Projects in Overview ........................................................... p. 4
CDEC Costs vs. Benefits (in $Dollars$) ........................................... p. 9
CDEC Contribution to Campus Community ..................................... p. 10
CDEC Service Highlights ............................................................. p. 11

1. Teaching: CSW/CLASP Enrollments
2. Teaching: CDEC Scholars Program
3. Course Deployment: CDEC Software
4. Outreach & Collaborative Initiative

CDEC Research & Development ...................................................... p. 14
CDEC National Profile & Leadership .............................................. p. 16

Appendix: Charts on CDEC Impact ............................................... p. 19
CDEC Mission & Strategy

CDEC has one basic mission: to improve education -- learning as well as teaching -- through well designed applications of advanced computers and computer-based technology. To this end, CDEC pursues three basic activities: I. Research & Development, with both in-house & across-campus projects; II. Technology Transfer, on campus, regionally, & nationally; & III. Educational Services, including a scholarship program and computer-literacy curricula.

Our R&D project areas (see below) reflect a dual focus on both teaching and learning: (1) productivity (programming/authoring) tools for both teachers and students; (2) computer-based tutoring systems that exploit artificial intelligence for instruction sensitive to both the expert's knowledge and the learner's needs; and (3) multi-media / simulation environments (eg., interactive video) designed to support 'hands on,' 'experiential' learning, to guide or challenge the learner's responses in domains of open-ended inquiry in the arts & sciences.

CDEC pursues a strategy of comparative advantage in its selection of projects to support (either in-house or across campus): a function of the center's strengths, the university's strengths, and opportunities for distinctive impact both on campus and nationally. For example: the former strengths dictate our emphasis on productivity tools, cognitive studies, and tutoring systems for the advanced-function workstation, while the national need for rigorous and imaginative approaches to education in value-laden domains motivates our multi-media projects in the arts, ethics, and policy studies (see below).

A corollary principle of priority in the selection of areas and projects is seminal impact on general/liberal education (inclusive of scientific and technological literacy), whereby priority is given to exemplary projects with wide and direct impact on university core curricula.

CDEC's operational standards for educational impact are qualitative as well as quantitative: to exploit computer-based technology in ways that have strategic (not merely local, instructional, logistical) impact; in ways that address significant, pandemic educational problems; in ways that facilitate learning as well as teaching. It's not enough that our products be used in many courses by many students, simply to facilitate local instruction or 'business as usual'; it's not enough that our computer applications prove themselves cost effective against traditional media in traditional settings. The following are six ill-defined but important things the computer should facilitate:

1. Intellectual activities, ambitions and goals not feasible by traditional means.
2. In particular, skills (or sensibilities) not well promoted by traditional means.
3. Learning opportunities for populations not well served by traditional means.
4. Cross-disciplinary collaboration and learning not well attained by traditional means.
5. Critical and creative re-thinking of our educational and pedagogical pieties that puts conventional wisdom about educational goals and standards under vigorous duress.
6. Research on the above.
CDEC Projects in Overview

I. Research & Development Projects ('In House')

Productivity (Programming/Authoring) Tools

1. CMU Tutor (A general-purpose programming language & authoring system; with applications portable across current & advanced-function machines; CMU Tutor itself available on workstations, IBM PC's & Macintoshes.) - Bruce & Judy Sherwood, Dave Andersen, Kevin Whitley et al.

2. Kyoto Common LISP port to Andrew/advanced workstations - Alan Sobel, P Covey

3. The VideoDisc Controller & HyperCard toolkits and extentions - Nick Spies

Tutoring Systems & Simulations

Logic Suite

4. ANALYTICS (3 PC & Andrew programs) - Bend, Aspenwall, Covey
5. Symbolization Tutor (Andrew) - L Burkholder, C Walton
6. Proof Tutor (Andrew) - Sieg, Covey, Pressler, Scheines, Sobel
7. VALID OnLine Course (TOPS & Andrew) - Scheines, Sobel, Covey

Math / Science Suite

8. Graphs & Tracks (Andrew & PC) - David Trowbridge
9. Sketch (Andrew) - J Larkin, C Scheftic, D Trowbridge, D Yee
10. CIRCE (Andrew) - Jill Larkin, Ruth Chabay

Social Sciences

12. PD World: N-Person Iterated Prisoners' Dilemma Simulation Environment - Leslie Burkholder, Chris Walton
13. 'Puppies': Statistical Simulation Lab - Jill Larkin, Dana Kay
Multi-Media Learning Environments

Project THEORIA (Testing Hypotheses in Ethics/Esthetics: Observation, Rationality, Imagination, & Affect)

14. Ethics Videodisc - P Covey, S Bend, Scott Roberts, R Cavalier
   (Right to Die: The Case of Dax Cowart)

15. Esthetics Videodisc - P Covey, M Roth, L Leizman, P Aspenwall, R Cavalier
   (Art Forgery: The Case of Van Meegeren's Vermeers)

16. Birth or Abortion: the Human Face of a Dilemma (proposal) - Covey
   - Broadcast video production
   - Generic videodiscs
   - Interactive program for ethical issues
   - Interactive program for gender studies

   (Based on interview research and book in progress:
    Birth or Abortion: Private Struggles in a Political World)

17. Multi-media workstation & development lab - R Cavalier, N Spies, S Bend

18. Pilot Video Delivery Labs - Covey, Cavalier, Joan Mitchell

19. National Security Archives Project (proposal) - Covey

20. Carnegie Natural History Museum Egyptology Project - Covey, Cavalier

21. Hunt Institute Botanical Videodisc Project - Cavalier

22. Swiss Poster Videodisc Exhibit - Cavalier

   - 'Re-purposing'/dubbing The Name Game (proposal)
   - 'Re-purposing' Annenberg/CPB Generic Language Discs
II. Technology Transfer & Dissemination

1. Inter-University Consortium for Educational Computing (ICEC)
   - Ken Friend, director; R Cavalier, assistant director
   - ICECNET newsletter & hotline, Stacie Hibino

2. Campus Outreach & External Relations - K Friend & R Cavalier

3. The Pittsburgh Interactive Learning Forum - R Cavalier

4. The Allegheny Intermediate Unit - C Scheftic

5. The McDonnell Foundation Program in Cognitive Studies for Educational Practice
   - Jill Larkin, director - Dana Kay, associate director

6. NDL Research Consortium - R Cavalier, P Covey
   National Demonstration Laboratory for Interactive Educational Technologies (NDL), @ Smithsonian Institution

7. APA Committee on Computer Use in Philosophy:
   - P Covey, chairman of Amer. Philosophical Assoc. committee
   - L Burkholder, editor, Computers & Philosophy newsletter
   - L Burkholder, on-line database & catalog of philosophy software
   - R Cavalier, AATP exec. director for annual Computers & Philosophy conferences

8. McDonnell Conference on AI & Education - J Larkin, R Chabay

9. CMU Electronic Publishing Project - W Arms, P Covey, R Minio

III. Educational Services: Programs, Teaching, Seminars

1. CDEC Scholars Program in Educational Computing (CSPEC) - C Scheftic

2. Computer Skills Workshop (CSW) - T Futhey, C Scheftic, P Covey

3. Computer Languages, Applications & Systems Program (CLASP) - P Covey

4. Intelligent Tutoring Systems Reading Group - Alan Sobel

5. The '87-88 Understand Seminar (AI & Education) - J Larkin
IV. CDEC-Supported Faculty/Student Projects (A Sampler)

CDEC Scholars' Projects (major showpieces)

1. Genetics Lab - Pam Reinegle
2. Chem Lab - Dave Thompson
3. Andrew Tutorial - Dave Thompson
4. UNIX Tutorial - Wayne Mesard

5. The WARRANT Project - D Kaufer, C Neuwirth, [P Covey]
   a. The NoteCard Program
   b. The Comment Program

6. The History Machines - Stephan Greene, David Miller
   a. The Great American History Machine
   b. The Universal History Machine

7. Cognitive Psych Labs (PC & Andrew) - S Greene, B McWhinney

8. AI & Probability Suite - Kevin Kelly, Clark Glymour, Scheines

9. Prince (Architectural Design Tutor) - Gerhardt Schmitt

10. Civil Engineering Structural Design Environments - Mary Lou Maher

11. ElectroMagnetic Field Suite - Jim Hoburg, Peter Levin

12. DEMOS / DEMAPS (probability & risk analysis) - Max Henrion, Chas. Weica

In addition to these showcase efforts, which have received major support from CDEC as well as (in several cases) substantial external funding, CDEC has provided whole or partial support for the following array of programs across CMU colleges. (Many of these projects have developed / are developing both Andrew and non-Andrew applications. The following list is based on 1986 catalog, hence it is dated. A new catalog will be available in 1988.)
In CFA: Musicians' Workbench, CAESAR, VEGA, PANDA, VIVACE, VOICE, CAMUS.

In CIT: ISMAP II, Construction Project Management Game, Lotus Project Scheduler, Linear Programming et al. tutors (4), SSSDS, Construction Bidding Game, Fields Animation Program 1 (FAP1), FAP2, Gauss's Law Program (GLP), CACHE (Computer Aided Control Hacking Environment), Interactive Control Systems Simulator (ICS), CONV (Convolution), CTFS (Continuous Time Fourier Series), CTFT (....Fourier Transform), DTFT (Discrete Time Fourier Transform), SAMPLE, POLE, DPOLE, Digital Signal Processing, Dr. Thevenin, ISPS (Instruction Set Processor Spec compiler and simulation system), Heat Transfer Tutorial, Diff Equations, Heat Flow w/ Cartesian Coordinates, Spherical Coord., Heterogenous Kinetics.

In H&SS: Go for Baroque, PC Cahiers program, IDEAS I & II, Interactive Nuclear Power Plant Simulator, EXPLORER (interactive exploratory statistics package), NETWORKER (interactive network analysis), QUESTAR (interactive graphics oriented questionnaire system), On-line Test Administration System (Psych).


CDEC/CDEC-supported projects: 75% of campus total

CDEC/CDEC-supported Andrew projects: 95% of total

We need to survey & assess course/classroom use of CDEC/CMU educational software, other educational software, and other generic software (a proposed joint CDEC/Academic Computing project).
CDEC Costs vs. Benefits (in $Dollar$)

**BENEFITS:** Fungible CDEC Contributions in Direct Service from 84:

- $680,000 direct grant support to CMU faculty/students
- $220,000 direct support to non-CDEC CMU staff
- $156,000 CDEC-purchased hardware donations/grants
- $385,000 technical support in CDEC programmer time
- $751,900 direct campus service in other CDEC staff time

\[ \text{Total Benefits} = \$2,192,900 + \text{oper. costs of} \ \$658K = \$2,850,900 \]

**COSTS:** E&GO Personnel/Campus-Support Budgets from 1984:

<table>
<thead>
<tr>
<th>Year</th>
<th>Budget (incl. oper. costs)</th>
<th>Budget (excl. oper.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>$272,600 - 71,000 (oper.) = $201,000</td>
<td>$201,000</td>
</tr>
<tr>
<td>1985-86</td>
<td>$301,000 - 77,000 (oper.) = $224,000</td>
<td>$224,000</td>
</tr>
<tr>
<td>1986-87</td>
<td>$313,000 - 81,000 (oper.) = $232,000</td>
<td>$232,000</td>
</tr>
<tr>
<td>1987-88</td>
<td>$432,400 - 87,000 (oper.) = $345,000</td>
<td>$345,000</td>
</tr>
</tbody>
</table>

\[ \text{Total Costs} = \$1,318,000 \ (\text{incl. oper. costs}) = \$1,002,000 \ (\text{excl. oper.}) \]

CDEC's fungible contribution in direct campus service and grant support totals (approx.) $1.54 million over/above CDEC's E&GO cost to the university since 1984, making CDEC a 'profit' center on its service side.

This net 'profit' to the university from CDEC's service operations excludes CDEC R&D funding and overhead, totaling **$2.6 million** since 1984.

In sum, CDEC has contributed *half* its external R&D funding to direct campus grants and service, while CDEC's external grant contribution to its university service is *twice* that of its university E&GO (cf. below).

*But what service has been provided? What has been its impact? What follows are some indicators and measures.*
CDEC Contribution to Campus Community

1. CDEC R&D-to-Service salary ratio (total funds) is 47/53% -- over half our total salary funds (external grant + E&GO monies) are spent on university service through '87-88 (Chart A).

2. 72% of CDEC service salaries have been covered by external grant ('soft') monies vs. 28% by university E&GO (Chart B).

3. CDEC has supported over 150 projects across campus (Chart C) with $680K in grants, in addition to hardware purchased at $156K (excluding Sun/RT loans) plus technical support at $385K.

4. Thus, CDEC grants have provided 72% vs. the university's 28% of the total cash support for educational computing applications on campus (Chart D).

5. 75% of the documented educational computing projects on campus have been generated/supported (in whole or part) by CDEC (Chart E).

6. 42% of the documented educational computing projects are Andrew; CDEC has supported/generated 95% of these Andrew applications (Charts F & G).

See Appendix for CHARTS:

A. Salary Distribution by Use (all sources): R&D vs. Service

B. Service Salaries by Source: 'Soft'/External vs. 'Hard'/E&GO $$

C. Distribution of Projects by College: CDEC-Supported vs. Independent

D. CDEC Support for Campus Projects by Source: 'Soft' vs. 'Hard' $$

E. CDEC Supported Projects = 75% Campus Total (95% of Andrew Projects)

F. Andrew Projects = 42% Campus Total

G. Distribution of Andrew vs. non-Andrew Projects by College
CDEC Service Highlights

CDEC will have cost the university $1,318,000 (total CDEC E&GO) by this FY since 1984, for which the university community will have received $2,850,900 in direct service or campus grant support -- a 'profit' to CMU of $1.54 million.

In addition to myriad administrative & technical support, CDEC service now includes teaching in CSW, CLASP & CSPEC:

1. Enrollments for '87-88: 1500+ Students in CSW & CLASP

Since CSW is a 3-unit course the 1200 students in fall and projected 300 students (including staff) in spring semester = 5400 stud.-units.

CLASP courses besides CSW (projected enrollments = ?) will include:

- Formal Methods of Software Engineering (Spring '88)
- Prolog & AI Techniques (Spring '88)
- Andrew (Spring '88)
- Prisoners' Dilemma Worlds: Computer Modeling & Social Choice
- CMU Tutor & AI Techniques
- HyperCard: 99 Exciting Do-It-Yourself Educational Applications

CSW also provides a rich and unique educational experience and employment for 40+ CMU undergraduate TA's.

2. CDEC Scholars Program in Educational Computing (CSPEC)

3. Course Deployment of CDEC Educational Software-Examples:

On-line logic courseware: 200+ students per year (+ 20 other schools)
Andrew physics software: 100+ students per year
CDEC/Philosophy AI & Probability software: 40 students per year
CDEC experimental statistics software: 60 students, fall '87
CDEC-supported writing software: 160 students per year
Great American History Machine: 30 students, fall '87
Art Forgery & Right to Die videotdiscs to run in 4 courses, spring '88
N.B.: 90% of the other 150 projects also deployed in courses.
4. Campus Outreach & Collaborative Initiatives by CDEC:

The extent and intensity of CDEC's collaborative and outreach initiatives surely rival (within scale) those of any CMU service unit and exceed those of any comparable research & development center.

Highlights:

CMU Colleges/Departments: CDEC, in collaboration with Academic Computing, has initiated a campus outreach program for colleges and departments to consult and assist directly with development or deployment problems and strategies (Examples below)

Academic Services: A sampler: CDEC has involved Michael LoBue, Assistant Vice President for Academic Services, directly in its vendor-support and development initiative for CMU Tutor. CDEC supported the design and founding of the Educational Software Library thru its first year. CDEC is providing five of the Academic Services seminars as well as three other campus seminars this fall. CDEC offered programmatic designs and monetary support to develop a CMU portfolio for a collaborative electronic publishing agenda (with Oxford University Press). CDEC administered (over a total of three years) two laborious rounds of equitable and equitable advanced-function workstation deployment across campus.

EDUCOM, the Consortium for Computing in Undergraduate Education (C-CUE), ICEC, CMU: CDEC has provided technical and logistical support for conferences, workshops, and software fairs held on campus. CDEC represents the university with presentations at national computing and professional conferences. CDEC runs hundreds of demonstrations every year, on and off campus (at several national conferences). CDEC provides technical & machine support for various sabbatical visitors and the H&SS Dana Fellows yearly.

H&SS: CDEC is providing the Modern Languages Lab with video player equipment to help enable the lab to deliver interactive video materials to its students and is consulting with the faculty on various innovation and funding strategies exploiting interactive multi-media. CDEC is helping the Philosophy Department solve its technical deployment problems with on-line logic course by working with Stanford University on a port to advanced workstations/Andrew.
CDEC Productivity Brief

CA&T: CDEC took the initiative to provide venue and hardware for Nick and Robert Spies of the Center for Art & Technology to implement their designs for a VideoDisc Controller for precision frame handling, editing and rapid prototyping off a stack of videodisc players. This project provides a working model for the management of stacks of video players/video archives on the distributed network.

SEI & University Libraries' Instructional Technology: CDEC is collaborating actively with both these centers on plans to develop facilities for the production and deployment of (interactive) video.

The ITC: CDEC provided five programmer years worth of labor on Andrew system development and deployment. CDEC and the ITC are collaborating on the implementation of a multi-media workstation, exploiting MIT's windowing/video software and CDEC's multi-media applications. CDEC's CMU Tutor serves as a prime 'sell' for Andrew.

University Libraries & Hunt Botanical Library: CDEC will help both libraries implement interactive video treatments of their poster and botanical print collections, respectively. CDEC involved library staff in the production of its art forgery videodisc materials, in which splendid collegial bonds were formed.

The port, documentation, & maintenance of a (Ibuki/Kyoto) Common LISP to the advanced-function workstations for the campus community was initiated and managed entirely by CDEC (with the site license negotiated and paid for by Academic Services).

CDEC organized and ran the Authors' Guild for Andrew (AGA) and holds a weekly interdisciplinary Study Group on Intelligent Tutoring for participants from departments across campus.

CDEC's Jill Larkin this year directs the Understand Seminar in Psychology and has organized it around topics in educational applications of AI and expert systems technology.

CDEC research staff teach regularly in academic departments of the university.
CDEC Research & Development

Over and above CDEC's campus development grants and service, the university benefits from CDEC's projects and distinction in basic research and development of educational technology (in which CDEC has been totally self-supporting to date).

CDEC is arguably the premier center in the world for educational computing for post-secondary education in the strategic areas of:

1. The development of productivity tools for the advanced workstation – CMU Tutor being our preeminent (but not our only) achievement. (Cf. CMU Tutor Technical Report. See CDEC Projects.)

2. The integration of cognitive science and disciplinary research in the development of intelligent systems and interfaces for computer-based tutors and problem solving environments. CDEC is developing several (see CDEC Projects) state-of-the-art systems for education in logic, physics, & the social sciences. CDEC's basic research in these areas is as distinctive a contribution as its application to educational software design.

CDEC has pending or in preparation over $4 million dollars in grant proposals to support this research & development work.

3. The design and development of multi-media learning environments for problematic domains of the arts and humanities for both current delivery systems and the advanced-function workstation (a new agenda, see below... and CDEC Projects).
CDEC Productivity Brief

A New Agenda: Multi-Media

CDEC has four innovative multi-media projects in development (for class deployment in the spring semester) and five projects in the proposal or negotiation stage -- involving, on our initiative, collaboration with MIT's Media Lab and Project Athena, the National Security Archives, The Carnegie Natural History Museum, WQED, LaserActive, University Libraries, and the ITC.

CDEC's multi-media agenda has been developed rapidly, aggressively, resourcefully, and imaginatively.

Our portfolio of actual and developing projects includes:

1. The Art Forgery videodisc -- for both PC's & workstations

2. The Right to Die videodisc -- for both...

3. The VideoDisc Controller software & hardware

4. Implementation of/on the Multi-Media Workstation at CMU

5. The 'Swiss Poster' videodisc (Craig Street Gallery, Nov. '87)

6. The Hunt Botanical Print videodisc

7. The Carnegie Natural History Museum Egyptology videodisc

8. The National Security Archives Policy Analysis Project

9. Modern Language videodisc projects (2)

10. Broadcast (w/ WQED) + interactive video productions of:

   Birth or Abortion: The Human Face of a Dilemma

   (based on an on-going research and book project)
CDEC's National Profile & Leadership

CDEC's national profile has grown rapidly in the last several months in the area of computer-based multi-media, mainly through our energetic collaborative enterprise.

CDEC's leadership in authoring/programming tools and tutoring systems is rooted in longer-term developments.

Jill Larkin, Bruce Sherwood, Ruth Chabay, and David Andersen are arguably the best at their trade in the world.

Larkin, Sherwood, and Chabay all have national and world-class reputations in their fields.

Preston Covey plays a leading role in his profession as chair of the American Philosophical Association's Committee on Computer Use in Philosophy.

After a year of vigorous paring, reorganization, development and recruiting of staff, CDEC research, technical and support personnel are the very best to be found.

CDEC's leadership and the distinction it brings to the university are exemplified by the following:

CDEC developers and educational software are preeminent in their fields – for example, this year:

Ruth Chabay recently won her second national award, this time for Best Tutorial in the '87 EDUCOM/NCRPTL competition, for her General Chemistry software.

Jill Larkin, David Trowbridge & Carol Schectic won a Distinguished Software Award in the same national competition for the Sketch program (in Andrew CMU Tutor) . . .
as did David Miller's (History) *Great American History Machine (GAHM)* -- this Andrew project has been wholly supported by CDEC and programmed by Stephan Greene of CDEC.

When CDEC's *Proof Tutor* was demonstrated at the '87 annual Computers & Philosophy Conference, our only competition in this field (an intelligent logic tutor project at SUNY Fredonia) folded its hand and asked to throw in with our team (P. Covey, W. Sieg, J. Pressler, R. Scheines, A. Sobel).

CDEC's videodisc *Art Forgery: The Case of the van Meegeren Vermeers* has been invited as the showcase presentation at the annual (June '88) American Association of Museums Conference session "Optical Media / Interactive Media: Where Are They Taking Us?"

**CDEC is headquarters for national consortia etc.:**

The *InterUniversity Consortium for Educational Computing (ICEC)* & its newsletter *ICECNET*

Pittsburgh's *Interactive Learning Forum (ILF)*, which sponsors bi-monthly conferences for local universities, colleges, schools and corporations with national leaders and developers in laser optical technology

The *American Philosophical Association'*s Committee on Computer Use in Philosophy, producing a quarterly publication and organizing the annual national conference.

The *McDonnell Foundation Program* in Cognitive Studies for Educational Practice, which sponsors both a research grant and a post-doctoral fellowship program.

CDEC maintains active collaborative liaison with the *Allegheny Intermediate Unit (AIU)* for the advancement of educational computing in secondary schools.
In the field of interactive multi-media technology, CDEC is:

A charter member of the National Demonstration Laboratory's Research Consortium, headquartered at the Smithsonian Institution in Washington, DC. CDEC staff consult on the NDL's agenda and consortium-member projects in electronic publishing and interactive laser-optical technology.

Co-sponsor and organizer of the national LaserActive '88 Conference, to be held in Boston next fall (LaserActive is an annual national conference on interactive laser-optical technology).

Featured with its Art Forgery videodisc at the American Association of Museums conference to be held in Pittsburgh in June 1988.
Appendix: Charts on CDEC Impact

Salary Distribution by Use (all sources): R&D vs. Service

Service Salaries by Source: 'Soft' vs. 'Hard' $$

Distribution of Projects by College: CDEC-Supported vs. Independent

CDEC Support for Campus Projects by Source: 'Soft' vs. 'Hard' $$

CDEC Supported Projects = 75% Campus Total

Andrew Projects = 42% Campus Total

Distribution of Andrew vs. non-Andrew Projects by College
Salaries (by use)

Full-time Salary Distribution (by use)

47.40%  R&D  Service/Admin.

52.60%
S&A (by source)

Service/Administrative Salaries (by source)

- Grants: 72.12%
- [Other]: 27.88%
Educational Computing Projects by College
(in number of projects)
Campus Support (by source 84-87)

CDEC Support for Campus Development
(by source 1984-87)

28.30%
Grants

71.70%
Supported/Independent Projects

CDEC Supported vs. Independent Projects
(CDEC Projects included)

25.43%
Independent

74.57%
CDEC Supported
Total Andrew %

Andrew vs. Non-Andrew Projects

Andrew 42.20%
Non-Andrew 57.80%
Andrew/Non-Andrew Projects By College
(in number of projects)