A Collaborative Learning Environment
for Intellectual Teamwork Across the Curriculum

Edwin H. Rogers and Cheryl Geisler
Department of Computer Science
and
Department of Language, Literature & Communication
Rensselaer Polytechnic Institute
Troy, NY 12180

Abstract While the solitary genius inventor remains a romantic icon, the modern workplace is dominated by collaborative activity. As products and services grow in complexity, collaborative design is becoming increasingly multidisciplinary and conducted by large teams of specialists (often including clients or client surrogates). Consequently, universities must prepare students for collaborative work.

This paper describes an experimental facility in which new pedagogical opportunities have been created for teaching teamwork in each discipline and across disciplines.

Introduction
Collaboration is an integral part of personal and professional life. Most collaboration is informal, but society and commerce have found it valuable to structure collaboration in a variety of formal ways. Legislatures and courts have codified rules for collaboration, for example. More commonly we engage in semi-formal collaborations in groups called committees or teams engaged in exploration of issues, decision making, design, operating complex systems (e.g., ships and TV broadcasts) or even sports.

We learn team behavior on the job in most cases. However, there is a need and a role for formal training in team work, particularly in teamwork which demands commitment and vigorous, shared intellectual effort.

Intellectual teamwork is, essentially, a "joint activity" in the sense defined by psycholinguist Herbert Clark. It depends upon the coordinated activity of participants in a way evident to even the most casual observer. We are all familiar with the stories of failed design coordination when designers find, after months of independent work, that the pieces don't fit together.

Those who have examined the discourse of intellectual teamwork more directly [12,2,7] have noticed, in addition, a rampant ambiguity in design language which makes the eventual coordination of joint action appear even more miraculous. Especially at the beginning of a project, designers don't appear to share much common understanding of what they will design: what it will be; how it should work; what need it addresses.

According to Clark, these kinds of ambiguities are gradually managed through a series of moves in which participants first project their understanding of the current state of activity and then affirm or modify that projected understanding through their responses. Through a series of such coordinated joint actions, participants accumulate what Clark calls "common ground" [5, p.43]. Such coordinated activity appears to be predicated not upon all participants sharing the same knowledge and values, but rather upon the equity of the interactions, the coordinated effort each participant contributes to ensuring that his or her partners garner equivalent benefits and shoulder equivalent costs [5, p.295]. In contexts fragmented by disciplinary boundaries, such equity is achieved, on the one hand, by acknowledging and valuing the contribution of each discipline and on the other hand, by using rhetorical and narrative techniques to authorize disciplinary-based knowledge in the common ground of participants' concerns.

Education in teamwork must develop understanding of team processes, enhance participation, and develop interpersonal and leadership skills.

Teaching intellectual teamwork is different from collaborative learning; the objectives of a team are generally not education itself but some quite different product. Because there is a team goal or product, educators have generally used discipline-specific pedagogies for teaching intellectual teamwork.

The teaching of intellectual teamwork is widespread and particularly so at Rensselaer where it is evident in...
architecture, communication, management and all branches of engineering. The faculty has, moreover, recognized the multi-disciplinary nature of design, particularly in engineering, and has made experience in multi-disciplinary teams a distinctive feature of a number of capstone courses. This has accentuated the importance of building mutual understanding and mutual trust within teams.

**Learning Environments**

For the most part, teamwork is taught in a practicum fashion; student teams are formed; engage in “team building” exercises; discuss personal strengths and weaknesses, team goals and strategies; parcel out responsibilities to individuals or sub-groups; share and assemble information and ideas; prepare models, reports and artifacts; and importantly, reflect upon their team experiences. These are things teams do together, and while individual work is crucial to team success, these activities are central to the team experience and success.

When teams gather to do these things, they often bring with them information and ideas in sharable forms — usually produced on a copier as paper handouts or plastic sheets to go on an overhead projector. Developing ideas may appear during the meeting on a black/whiteboard or overhead projector. The higher tech team will use a computer, networking, a digital projection system, and possibly an electronic whiteboard.

A number of groups have created and experimented with electronic enhanced meeting facilities using all of the above tools as well as personal computers for each team member and special group software designed to improve the team’s progress. This groupware is usually specific to a particular group activity or a particular discipline.

Teaching intellectual teamwork to classes of more than a handful of students demands much greater capacity than a conference room offers --- and new strategies for teaching many teams together. Just to add to the challenge, we ought to consider real-time linking to distant student teams and teams separated in space (but not time).

In the remainder of this paper we describe a new classroom for intellectual teamwork at Rensselaer Polytechnic Institute.

---

**Figure 1. An artist’s rendering of the Rensselaer Collaborative Classroom**

**Design Participation & Facility Description**

The Rensselaer Collaborative Classroom (CC) can trace its conceptual ancestry to computer-based decision support systems [13,14,15,8] and more recent computer-enhanced collaborative design facilities with branches of the family related to distributed collaboration and various kinds of groupware [1,4,6,10,11]. Its immediate predecessor at Rensselaer is the Design Conference Room (DCR) brought on-line in 1994 with the considerable help of an NSF CISE grant [http://dcr.rpi.edu]. The DCR has hosted numerous task forces, design groups, committees and a few classes. The latter have come from courses in architectural CAD, rotorcraft design, electric vehicle design, advanced computer algorithms, document design, animation, and website construction. The successes and limitations of the DCR have accentuated the need for a larger space with
even richer media capabilities and more pedagogical options. The CC is intended to be a classroom as distinct from a conference or meeting room. Rensselaer’s experience in pioneering “studio” courses in physics, mathematics and electrical engineering has also influenced CC design.

The CC provides seating for teams of two to six students each at technology-enhanced conference tables. At each table, a shared high-end Windows PC serves students via student-supplied laptop computers, shared keyboards and mice, and large-screen color monitors buried in the table. This arrangement helps preserve natural lines of sight, allowing users to talk freely and to see the front of the classroom.

A switched 10/100 base-T network connects each team via a gateway to the campus and Internet, and Ethernet ports at each of the student seats allow users to link their laptops. At the front of the room, a custom-designed instructor’s podium houses a Windows PC and input devices, and a high-end projection system.

Users of the room log into the Collaboration Net, specifically designed to allow them to share control of their team’s “public machine” located at their tulip-shaped table. Once logged in, they gain access to a wide variety of software as well as campus computing and Internet resources. Additionally, a team may elect the CC podium machine as their “public machine” and choose from an array of multimedia tools -- such as VCR, cable TV box, compact disk player, speakers, document camera and Zip drive -- to share ideas with the entire class. In this configuration, they can also use a high resolution projection system to make general presentations.

In order to serve the university community broadly, the CC’s systems carefully segregate discipline-specific features from generally useful features. In particular, the Collaboration Net software written some years ago for the Design Conference Room was designed as “metagroupware” to support media sharing protocols independent of the applications software users of the facility needed for their work. This approach has been carried over to the CC where the new version of the software (written largely in Java) permits the use of a variety of platforms and dynamic reconfiguration as team members come and go with their portable computers. Moreover, team sessions may join into multi-team collaboration sessions as the need arises either to merge project work or for pedagogical purposes.

Classroom Activities

Based on prior experience in the Design Conference Room, the CC has been designed for six major kinds of studio activity common in courses requiring intellectual teamwork:

Instructor Demonstration: Members of all student teams may view a demonstration done on the instructor's machine using the projection screen at the front of the room. All or selected teams may also view a demonstration on their team machine by connecting to the instructor’s. And, finally, a single team can view a demonstration by an instructor who moves physically to the table to take control of their machine.

Peer Learning: Students may use the CC to practice demonstration techniques in a supportive peer learning environment. Once demonstrated by the instructor, techniques may be practiced at each table by students taking turns control of their team’s computer. Fellow team members provide help, making total team learning synergistic.

Team Meeting: Students may use the CC for team meetings both during regularly scheduled class time and after hours. Using ethernet or disks, students can move material previously generated on an individual’s computer to the team’s. In the course of the meeting, this material may be refined or alternatives generated as team members share turn-taking control. At the conclusion of the meeting, results can be redistributed from the team to individuals. Shared file space on the campus system will also be available.

Instructor Consultation: As individual teams meet, instructors can move through the CC for consultation. A team can show its work or make informal reports to the instructor watching one of the team’s monitors. When appropriate, instructors can take control of the team’s machine to illustrate a concept or demonstrate a technique. Instructors can also establish links to other teams in order to demonstrate alternative approaches.

Client Consultation: Teams can use the CC to consult with clients. Sitting with team members at the table, clients can see and comment on the developing project. By taking brief control of the team’s machine, they can also suggest changes. Material generated for and during the consultation can be electronically transmitted or printed out in hard copy. Linking to distant clients through global networks is another option.

Presentation & Critique: The CC provides an ideal environment for the presentation and critique of team work. Students can connect their machine to the instructor’s and project their work for presentation to the entire the class. Other teams and instructors may not only critique this work, but manipulate it in ways to suggest future directions.

2 Copyright © 1997 shareDesign, LLP.
Early Experience

Recognizing that teachers may find the CC’s facilities a bit bewildering, we have had prepared an on-line user’s guide as well as tours and demos. An active program to help instructors prepare to use the CC will have to continue from term to term.

The CC is to come on line in September 1997 with a number of courses scheduled to use it in the coming year. These include Software Design & Documentation, Visual Design, Writing for the World-Wide Web, Human-Computer Interaction, Science & Technology Studies, Rotorcraft Systems, and Computability & Compilers. A seminar among those using or considering use of the CC will help faculty to share what works and what doesn’t and to (collaboratively) learn and invent successful techniques and facilities for teaching intellectual teamwork.

The first named author will use the CC for the first of the courses listed and will use all six modes described above during the course. CAD tools will be demonstrated with students able to take turns running “what if” exercises from their seats while the whole class watches. Project presentations for clients will take place at individual team tables as well as for the whole class. Students will bring resources relevant to their particular roles and expertises. They will summon these through campus and Internet-working.

The Human-Computer Interaction courses will share the CC’s facilities with distant students using video communications through a commercial bridging service.

References


As of this writing the CC has not come on line. Early experience with it will be part of the presentation at the conference. Further details will be reported at future opportunities.