2 Teaching CAD as a Foreign Language

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By looking at the well-developed[1] discipline of language teaching, we can improve instruction of computer aided design communication. Language teaching not only breaks down a complex field into attainable steps, but also shows how learning strategies and attitudes can enhance mastery. Guiding students in learning approaches will equip them to deal with constantly changing technology. Even at an introductory level, awareness of the learning process can heighten learning. Thus, giving a conceptual framework and enhancing resource-finding, brainstorming and coping abilities will lead to threshold competence.

Practicing these strategies on realistic projects hones the ability to connect concepts to actual situations. Both design or research projects exercise resource-usage, task management, crisis management, but specifically, collaboration exercises which engage the students with a real audience can provide strong motivation and link academic study to practical concerns. Ideas about teaching techniques are documented with examples from the University of Hong Kong.

INTRODUCTION

While many people acknowledge computer aided architectural design's linguistic aspects, this has not been fully exploited in teaching. In both CAD study and language study there is a need to frame ideas in a new way in order to communicate. We can take advantage of the way architecture and the graphics needed to represent architecture have linguistic characteristics in digital design studies. Language teaching provides concepts and methods for gaining natural fluency in a new medium.

(For clarity, "CAD" and "digital design" will be used interchangeably to mean exploring and expressing design ideas with computer technology. My examples primarily refer to visualizing tools such as graphics, modeling, rendering, animation, multimedia, virtual reality rather than to analysis tools.)

1.0 WHY FOCUS ON COMMUNICATION?

While many laymen assume that math skills make a good architect, few realize that communication skills are much more critical. Whether in planning, design or construction, architects play a pivotal role in conveying and interpreting information. As facilitators of organizing, processing and publishing information, computers will become increasingly used for these purposes in professional practice. So learning how to use computers to communicate is key to becoming an effective architect. Throughout the HKU CAD curriculum, we focus on clear communication. Communication exercises

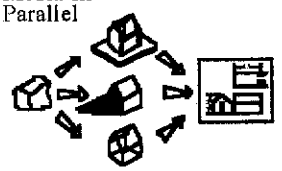
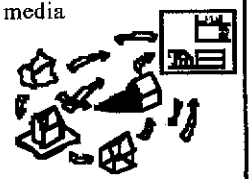
in computer classes can humanize a potentially cold and intimidating subject. This fits in with the need for computers to accommodate the less rational side of architecture[i]. Without neglecting to show the computer's expertise in logical, geometric order, we can also show the its utility in connecting human beings. Encouraging the class to be a networked community can mitigate the anonymity of a large class size. Our experience in using wider networked collaborations shows how compelling connections to people can increase motivation and open vistas.

The incentive of a social relationship can stimulate response and along with it, creativity in the method of responding. Expressing ideas in written or graphic form requires re-articulating ideas and reconsidering principles and priorities. Particularly if a student must translate from one medium to another and abstract the subject, he or she must re-examine the matter. So in working on the assignments for CAD class, the student develops both cognitive and technical skills.

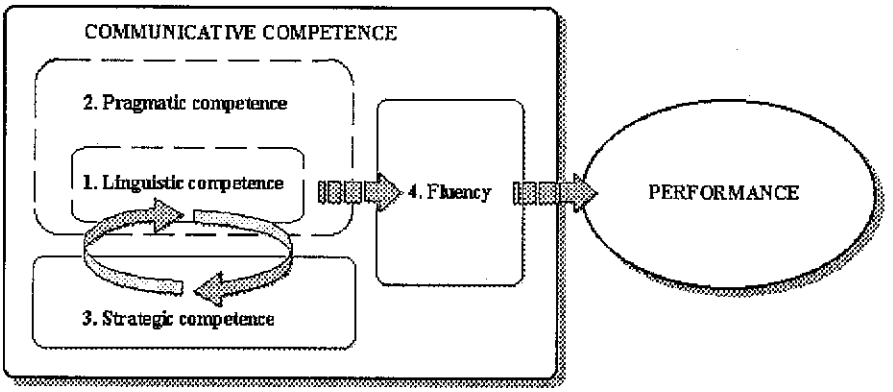
Our communication focus works well with the specific profile of our students. We have tailored our curriculum to our Chinese students who need enhancement of linguistic and visual literacy. They enter the architectural studies program with excellence in exam-taking, but deficient in visual arts. The ubiquity of English, Cantonese and Mandarin means that it is difficult to master clear expression in even one of the languages[ii]. Therefore we work on boosting their competency in graphic, verbal and written expression throughout the curriculum. This cultivation of expression fits naturally into classes where we are working on digital methods.

1.1 Curriculum Framework: Stepwise development to media fluency

At HKU, our digital design curriculum reflects the need to build up the media communication skills gradually. Beginning classes provide an introduction to digital concepts through a sampling of different applications. At the intermediate level, students are given structured ways to use methods in their design projects. Once they have passed through these levels, students can freely use the methods for design and research. In several of the optional upper level courses, computer techniques are supported much in the same way that language is developed in writing-intensive classes. These classes use computers as vehicles for investigating and expressing ideas.

LEVEL	BEGINNING	INTERMEDIATE	ADVANCED
MEDIA USE	Basic Concepts  Individual Media  Media in Series 	Media in Parallel 	Fluid mix of media 
PROJECT TYPE	Short Exercises	Design Projects	Design & Research
FOCUS	Technique and Communication	Technique & Content Relationships	Content- Oriented

2.0 SIMILARITIES BETWEEN CAD AND LANGUAGE STUDY



Components of communicative competence
after Claus Faerch, Kirsten Haastrup and Robert Phillipson's, *"Learner Language and Language Learning"*, Multilingual Matters Ltd, Clevedon, 1984.

The importance in clarity in expression unites CAD techniques with language. In the latter, communicative competence is defined in 4 linked parts[iii]:

- Linguistic competence, or understanding about sounds, words and grammar
- Pragmatic competence, or the ability to use language correctly for specific situations
- Strategic competence, or the ability to solve communication shortcomings with strategies
- Fluency, or the ability to express with ease.

In CAD education we aim for the same goals, but in the realm of the visual expression.

In both digital design and language, nuance of expression is accommodated through complex systems. They both have basic elements, which may be grouped into phrases, and then used together "appropriately and generatively"[iv]. This need to find deeper understanding is reiterated in looking at how even individual words require attention. According to Faerch[v], to fully "know" a word one must:

- know its full meaning potential, not just 1 specific meaning.
- know what the appropriate situations for using the word
- know in what ways the word can combine with others
- know the relations between the word and other words

Since both language and CAD techniques share an expressive intention and systemic complexity their teaching can be similar. In beginning language classes, the students start by mimicking the teacher's correct pronunciation of words, then phrases and sentences. Rather than repeating words, design students learn about graphic primitives

such as lines, arcs and planes, which may be assembled into motifs which are analogous to phrases. Students can follow CAD tutorials which lead them through models of correct usage of the commands just as language students parrot model sentences. By initially substituting parts into given examples, they can successfully create their own fledgling variations.

2.1 Levels of syntax: Computer and Architectural Order

But as Howard Gardner points out, expression depends on "not only the literal mastery of syntax, but also the capacity to construct narratives of different degrees of complexity"[vi]. If syntax is taken to mean the rules which govern the structure of a system, then CAD students have to master many different kinds of syntax. Syntactic rules govern the way that the computer can accept information, as in command word order, as well as higher level ordering of data structures and architectural system components.[vii]

Correct command order can be easily mimicked, but abstraction of graphic/architectural components into their underlying structures requires some sophistication. The understanding of architectural order separates older professionals requiring technical skills from young architectural students with little knowledge of architectural systems or low graphic literacy. In language learning, a similar thing happens: previous knowledge about the native language guides the learning of a second language. "Background knowledge serves as scaffolding to aid in encoding information from the text."[viii] Familiarity of what makes up a language gives a strong basis for learning one: the student knows to some degree what they are searching for and what are the possibilities of the end result.

Reading before writing

So while language learning classically falls into the verbal and written modes of receiving and expressing: listening, speaking, reading, & writing; computer representation has various modes which evolve with the technology. Expression in any one of them presupposes reading comprehension of the graphic conventions. For this reason, we have delayed the beginning of the introductory CAAD sequence from the first semester of our program to the second, in the hopes that a stronger foundation in the graphic "reading" can make the CAD studies more meaningful. Without prerequisite or concurrent graphic training, the students have little idea what to do with the tools.

2.2 Introductory CAD at HKU

Two major themes inform our introductory course:

- the nature of digital organization and manipulation
- the importance of the fit between form and content

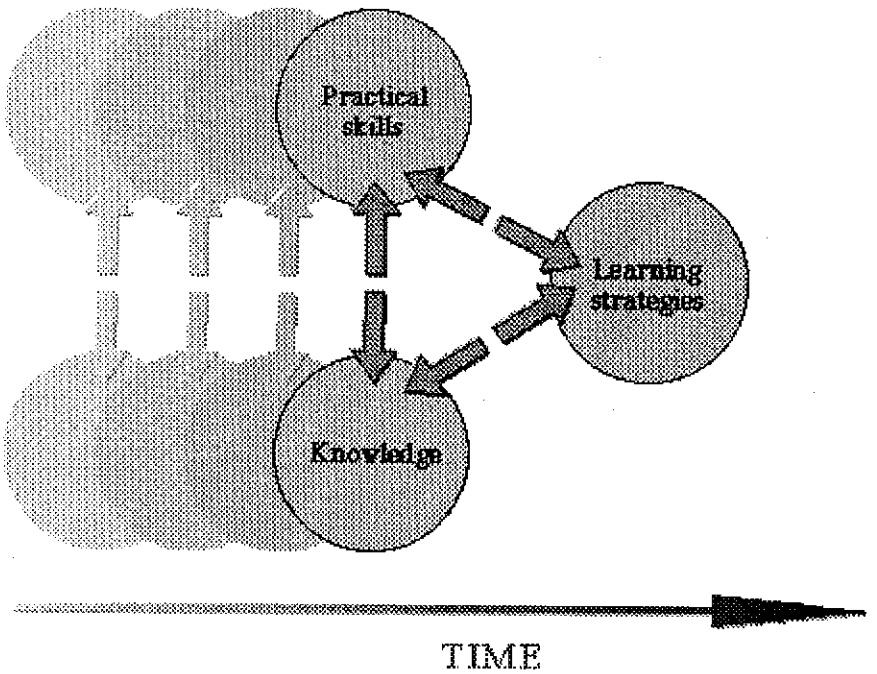
The underlying structure of computer information is taught by emphasizing common qualities about data manipulation across a series of applications. Introducing concepts such as data types, modifiers, attribute styles in simple applications can provide the abstract backbone that accelerates learning of more complicated ones. Emphasizing the underlying concepts promotes deeper meaning and enhances recall.

We have experimented with teaching different software for this course and the selection will continue to evolve with the technology. Currently we teach system basics, 2D graphics applications and network communications in the first year and 3D modeling, animation, rendering and HTML in the second. We introduce these applications one at a time and then finishing the course with a unifying page layout (year 1) or multimedia presentation (year 2). This allows the student not only to summarize the work, but also to understand data linking and dependency.

2.3 Introducing digital and architectural syntax

The students need to see this overall structure of document links as well as the order within a document. One advantage CAD has over language, is that the organization of a computer drawing should be quite similar to its subject, while the structure of a sentence can be quite different. In computer modeling, we can emphasize the organizational parallels of architectural language and data organization by using architectural examples to illustrate CAD's symbols, layers and hierarchies.

3.0 LEARNING FROM LANGUAGE LEARNING



Since there are strong parallels between language and CAD learning, we need to take advantage of methods proven in language training. Most important is the idea that we need to teach learning strategies and attitudes rather than just pragmatic skills or knowledge.[x] Although the commercial allure for students to become wizards at the latest release of AutoCad is strong, more lasting is the ability to figure out what to with the next big thing. The ephemeral nature of technology means that we have an obligation to build learning skills into our CAD classes. Language classes can show the way.

3.1 Start by supporting learner autonomy

Giving the students the skills to learn on their own is important not only because of the reality of large class sizes, but also because everyone eventually needs to find their own way. Luckily, computer tools often are accompanied by self-paced tutorials, on-line help and reference manuals. But language self-access centers have shown that merely providing these materials is insufficient: we must provide self-access skills along with self-access tools. The flood of information on the WWW shows how important it is to build resource-finding skills and resource-using skills so that everyone can efficiently target, find and use information. Drilling students on how to get into applications, find the self-help tools, and then save or quit is very basic, yet extremely important.

Language teachers have found that drilling very beginning students with stock phrases meaning "I couldn't hear you" and "I couldn't understand" allows them to learn more effectively through interaction. While our Asian students would benefit by becoming comfortable with those culturally taboo phrases, they can stay mum at first and ask their questions quietly to the computer. In computer studies, the equivalent stock phrases might be

"What does the tool or command do?"
"What actions are required?"
"What's the correct syntax?"
"Show a simple example of this function."
"Guide me in using the tool step-by-step"

While an on-line help facility can answer these questions, a tutor can react to the student's non-verbal signals as well as explicit commands.

Learning Strategies

Strategies are creative ways of compensating for lack of linguistic competence. For example, students who 1) seek frequent practice chances and 2) use patterns and rules for intelligent guessing are cited as successful strategists.[x] The most successful learners don't rely on only one successful method for study, but rather retain access to an array of techniques which is used as required. [xi] Training about how to use strategies is most effective when it is highly explicit and when the learner made aware of them within the context of a project. The projects give practice in adopting the strategies to new situations. This is just one example of how meta-cognition, or awareness about the learning process can aid in learning.

Overcoming Roadblocks

Another aspect that should be flagged is contingency planning. Since the goal of learner autonomy in CAD is to develop the resourcefulness to face changing technology, a critical strategy is planning for difficulties. Since neither technology nor humans are perfect, we need to have techniques for coping with the inevitable problems. While no one is ever careful enough to avoid some inadvertent data loss, guidance and warnings can minimize the damage. Accepting stumbling blocks as part of the process of development rather than seeing them as signs of failure promotes progress in any pursuit, whether it be weight loss or architectural design.

Developing a Learning Culture

"Every teacher of a second language is a teacher of a second culture as well"[xii]. Teachers convey much more than the content of the material, which is why classroom lessons are needed to supplement books. Design teachers can promote a computer "culture" in several ways. By creating a work environment conducive to cooperation, there can be a classroom or networked culture. This can be either live or on-line. Another sort of computer "culture" comes from putting computers in context. Readings and examples of how technology affects the creative and pragmatic possibilities in different specializations will alert students of the importance of digital know-how.

Healthy Learning Attitudes

The importance of the student attitudes towards learning is clearly shown in language education and unfortunately ignored in some architectural schools. Ideas such as "enabling goals"[xiii] and "threshold competence" [xiv] recognize that feelings of achievement spur further exploration. Working with the students to guide them in achievement of these intermediate steps can build the self-confidence which supports independent exploration. Attainable "enabling goals", such as one-week long graphic exercises, give a chance for the students to become familiar with the mechanics of putting pieces together in a correct fashion.

Threshold competence names a hypothetical minimum proficiency level which allows the student to reinforce formal study with reading in areas of interest. Being able to rely on tediously learned skills for free exploration gives a great feeling of progress, which can otherwise easily fade in long, challenging courses. The counterpart in CAD study is when a student who is initially forced to grapple with machines becomes addicted to trying out the new technology for him or herself. In this case, the mastery of one piece of software makes the next much simpler, especially with interface consistency. The whole point of introductory courses is to provide threshold competence and its accompanying excitement.

4.0 APPLYING CAD SKILLS

4.1 Promoting Resource-using skills through projects

Once students have rudimentary practical knowledge and skills to teach themselves, they can go on to using the technology. We have found that the best way to do this is with projects. Projects provide scenarios for applying techniques appropriately and often create situations which require strategic thinking. Most of our projects are based on the actual communication needs of the students in order to maximize motivation. We assign necessary items like resume and portfolio layout for desktop publishing and encourage the use of design studio projects as subjects for intermediate level.

An important aspect of a project-based curriculum is that it requires active thinking and response to constraints, rather than the passive absorption of attending lectures. Students must take charge of the task's management. In planning, organizing, executing and reviewing a project, a student's "task awareness", another meta-cognitive skill, is increased. Newell & Simon[xv] explain that a person must visualize

- the task goal and subgoals

- the possible states of the task in progress
- the constraints of task performance.

By working on projects, students exercise these planning skills and become better students. In addition to defining the scope and focus of the project, they must identify appropriate media tools for the project and apply them effectively.

Since our students need to learn the affordances and constraints of traditional as well as digital tools, we interweave their introduction in the undergraduate program. Through first precedent studies and then design work, they work in different types of media. We have found it effective to write problems in the second year design studio which require particular media for particular purposes at different phases of the design process.[xvi]

4.2 Communication techniques in research-oriented options courses

For the upper level students, we assume the students have linguistic, pragmatic and strategic competence and focus on fluency. This is best done as through projects in one of the three areas of concentration: History, Management and Technology. While the technology courses naturally focus much more on digital methods, in many of the classes, the students use the computer for:

- Accessing databases and library resources through networks
- Organizing, analyzing, processing and archiving information
- Integrating different forms of information into multimedia
- Visualizing information for presentation and publication

Most of the classes focus on independent or group investigations which depend heavily on digital research and publishing techniques.

4.3 Web Publishing as Communication Project

Our students at all levels have been using the World Wide Web (WWW) Hypertext Markup Language (HTML) format for presenting both research and design ideas. Publishing in this fashion requires the students to organize their thoughts into nodes and links and then translate them into screenfuls of images and text. It provides a visible record of the classes' work for discussion.

In the 1994-95 school year two classes, Computers in Architecture and Changes in Architectural Depiction required presentation of independent research work using this format. In the 1995-96 school year, five classes including undergraduates have been documenting their work in HTML format. We have found the HTML format to be a good one for network collaborations.

4.4 Communication Techniques in Collaboration Projects

To bring the communication process to life, we pair our students with others remotely located. The distance makes digital information a strong and inexpensive method of communication. The students are pushed into a realistic experiential learning situation: if they don't communicate, then their partners let them know that they are disappointed.

The live audience provides a motivation for getting ideas across clearly as working relationships develop. Because the students themselves act as audience for their partners, they are reminded of what makes the communication obfuscated.

We have been running an annual international exchange, putting together students to work on a mutual design project, since 1993. This year's Virtual Design Studio[xvi] attempted to encourage collaborative partnerships through complementary roles. Each project team had at least one Hong Kong student to act as the local designer or consultant and one foreign student to work together on a monument to Hong Kong's 1997 handover to China. The foreign students were initially given little information about the territory so that they would need to get it from the Hong Kong students. Communication was primarily through e-mail, secure FTP accounts, Web pages, and video-conferencing.

We found that the large number of schools involved (6) constrained schedules, aggravated the delicate technology and complicated live communications. Working with just two schools at a time would allow a longer project than 2 1/2 weeks. While decreasing the number of participants would make the project simpler to manage, it would decrease the technical support synergy. Due to technical constraints and start-up time, many of the design discussions remained embryonic, but the pragmatic technical problem-solving was very effective. Live text, video and audio of varying qualities linked our technical experts as we experimented with transmission settings. The live communication gave a compelling vitality to the network exercise.

FUTURE DIRECTIONS

For the future, running a class between a distanced pair of schools for a longer time period looks promising. Reducing the number of schools to one at a time will make it easier to get objectives aligned and logistics set-up. With a longer time period, student relationships could be established during a period focusing on developing technical skills. This would provide the necessary prelude for the more difficult and fragile design process.

Cultivating a strong design dialog requires attention to human factors that make communication work well. The networked studio gives us a compelling way to explore the potentials of digital design with colleagues many miles away. In this project and throughout our curriculum, we hope to more consistently apply the principles outlined here from language learning. The valuable meta-cognitive skills such as *task-awareness* and *attention to abstract structure* can be explicitly taught in many different ways. By focusing attention on the communicative aspect of digital tools, we hope to spur new techniques for both autonomous and collaborative learning.

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[i] See Paul Laseau's keynote address, "Howard's End" from ACADIA '94 Proceedings for notes on the importance of human perception in the design process.

[ii] My own experience in studying Mandarin and very basic Cantonese has provided the impetus for this investigation. Evening classes with Amy Chi Man Lai and Sarah Lu

Tsou showed me how interactive methods and attitude building could bring energy to the classroom.

[iii] Faerch, C., K. Haastrup, & R. Phillipson's Learner Language and Language Learning, Avon: Multilingual Matters, 1984, p. 168.

[iv] Gardner, Howard, *The Unschooled Mind,* Basic Books, 1991, p. 65.

[v] Faerch, C., *ibid.*

[vi] Gardner, op.cit, p. 74.

[vi] For CAD graphics which follow architectural rules in a grammatical fashion, see works such as G. Stiny & W. J. Mitchell's "Counting Palladian Villas" in Environment and Planning B 5, 1978; p.5-18.

[vii] Stall, Steven et. al.'s "Prior Knowledge and Difficult Vocabulary in the Comprehension of Unfamiliar Text" in Reading Research Quarterly, v. 5, 1995.

[ix] Gardner, op. cit.

[x] Rubin, J., "What the 'Good Language Learner' Can Teach Us" in *TESOL Quarterly*, no. 9, p. 41-51.

[xi] Oxford, R., and M. Ehrman, "Adults' Language Learning Strategies", in *System*, v. 23, no. 3, Elsevier Science, 1995, pp. 359-386.

[xii] Saville-Troka, M. *Foundations for Teaching English as a Second Language*, Englewood Cliffs, NJ: Prentice-Hall, 1976, p. 48.

[xiii] O'Malley, J.M., and A.U. Chamot, *Learning Strategies in Second Language Acquisition*, Cambridge Univ. Press, 1990.

[xiv] Jones, Francis, "Learning an Alien Lexicon: a teach yourself case study" in Second Language Research, V. 11, No. 2, June 1995.

[xv] Newell, A. and H. Simon, *Human Problem Solving*, New York: Prentice Hall, 1972.

[xvi] The project which teaches the link between data structure to kit-of-parts building structure is described in Cheng, N., "Linking the Virtual to Reality: CAD and Physical Modelling" in Tan, M and R. Teh, eds, The Global Design Studio, CAAD Futures '95, Singapore.

[xvii] Wojtowicz, J. (ed.), Virtual Design Studio, Hong Kong University Press, 1994.