APPLICATION OF COMPONENT DISPLAY THEORY IN DESIGNING AND DEVELOPING CALI
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ABSTRACT
Component Display Theory—(Merrill 1983; Merrill, Kowallis, and Wilson 1981) has been developed to be an analytical theory-based instructional design guide. It was the rationale underlying the design of the TICCIT computer-assisted learning system. It forms also a major foundation for hundreds of hours of instruction designed by Courseware, Inc. This paper discusses step-by-step procedures of its use in designing a goal-oriented Computer Assisted Language Instruction (CALI), and in quantifying the effectiveness of the instruction as a preliminary evaluation tool.

KEYWORDS: Component Display Theory, instructional design, generality, example, practice

During the past decade there has been an increased emphasis on the systematic design of instruction and programs (e.g., Baker 1973; Dick and Carey 1978; Briggs 1977; Gagne and Briggs 1979). As the result of the efforts, a body of systematic knowledge has been accumulated so that the art of instructional design can move toward the science of instructional design. However, there is still great need to translate the accumulated knowledge of scientific instructional design into operational step-by-step procedures easily usable by practicing instructional designers.

M. David Merrill and his associates (Merrill 1983; Merrill, Reigeluth, and Faust 1979; Merrill et al. 1977) have integrated much of the body of accumulated knowledge of instructional design and have developed a scientific and practical instructional development guide, which is called "Component Display Theory." The Component Display Theory (CDT) provides the needed operational procedures, along with prescriptions for its optimal use, for an instructional designer to use in the process of developing an effective, efficient, and appealing instruction. CDT is particularly applicable in designing computer assisted instruction.

CDT has been used in a significant amount of applied instructional design. It was the rational underlying the design of the TICCIT computer-based instructional system (Merrill, Schneider, and Fletcher 1979; Hendricks et al. 1983), and has been a major theoretical framework for the design of hundreds of hours of instruction designed by Courseware, Inc. The prescriptive principles of CDT have received considerable research support in both laboratory and field experiments (Merrill, Olsen, and Coldeway 1976).

The purpose of this paper is to examine some critical areas of the CDT highly applicable in CALL and to demonstrate how the principles of CDT can help in designing professional goal-oriented CALI that would eliminate much of the tedious tryout and testing that is done traditionally and intuitively. In other words, this paper attempts to show how the CDT can help in converting the art of CALI based on tradition and intuition to a more scientific theory-based CALI, which can have predictable results, without much of the trial-and-error finding procedures.

Propositions of Component Display Theory
CDT has identified valid instructional and performance variables and suggests a taxometric organization for relating these variables in a way which facilitates a systematic theory-based approach to instructional design.

Primary Presentation Forms
CDT postulates that any instructional presentation consists of a series of discrete displays. The fundamental displays which characterize all instruction of the cognitive level are called the primary presentation forms. There are four primary presentation forms formed by combining the two elements of instructional content, Generality ("G"—the main ideas or general case) and Example ("e.g."—instances or specific cases), with the two modes of presentation, Tell ("T"—telling or showing the student) and Question ("Q"—asking the student). The resulting primary presentation forms (PPFs) are tell-via-generality (TG), question-via-generality (QG), tell-via-example (Teg) and question-via-example (Qeg). (See Figure 1.)
CDT prescribes that certain secondary elaborations when added to a primary presentation at a given task level will facilitate student performance on the posttest. For example, the generality can be presented in a verbal form, and a secondary elaboration can be added by a form of a diagram, algorithm, mnemonic, or just a simplified form of the generality in a box so that students can easily and efficiently review the generality. Based on the postulation of PPFs and the assumption that some secondary elaborations, when added to the PPFs, will enrich the instructional presentation, CDT suggests, stated generally and without qualifications and limitations, the following eight propositions for instructional display.

**Eight Propositions of Component Display Theory**

1. **Primary Presentation Forms.** A segment of instruction should include all three of the primary presentation forms: generality, example, and practice. A segment is defined as that instruction designed to teach a given generality or coordinate sets of such generalities.

2. **Primary Presentation Form Sequence.** The primary presentation forms for a given segment of instruction should be sequenced in some variation of generality-example-practice. Acceptable variations include the use of a reference example simultaneous with or previous to the presentation of the generality. Such presentations should include additional examples following the presentation of the generality.

3. **Primary Presentation Form Isolation.** The primary presentation forms for a given segment of instruction and accompanying elaboration should be identified and isolated in such a way that a student can easily locate, skip, or review any given form. It is common experience that typical instruction includes generality with much elaboration in such a way that it may be difficult for students unacquainted with the subject matter to separate the main ideas from the elaborated material. This situation is called *instructional hide-and-seek* because the student must look for the key ideas that are embedded in the more elaborate textual presentation. The isolation proposition indicated that generality, example, and practice should be clearly separated and identified for the student by means of some type of graphic or auditory convention.

4. **Learner Control.** The student should be able to alter the primary presentation form sequence by returning at will to previously presented forms after having studied subsequent displays. In other words, the student should be able to return to the generality after studying an example or practice display, skip to a practice display before studying the generality, etc. Research on learner control (Merrill 1983) indicates that merely providing the opportunity for student choice and a rich array of displays from which to choose are not enough. An adaptive instructional management system that assists the student to use those displays from the available array should be provided.

5. **Generality Representation.** The generality should be restated, represented in other than verbal form, and/or be elaborated via a mnemonic or an algorithm. Often generality is usually presented by verbal/written form only. However, the generality may be displayed in three ways: (a) by presentations of the actual object or enactment of an event, (b) by a pictorial representation, and (c) by a written or mathematical representation. The generality display should have more than one form, and should include other helps such as memory aid devices (e.g., mnemonic, heuristics, and algorithm) or a brief summary in a box.

6. **Instructional Help.** Example displays should be elaborated via instructional help prompting (such as underlining, bold print, color, exploded diagrams, or other kind of attention-focusing devices), and more than one form of representation (e.g., a simplified verbal description and a visual representation). Practice displays should include instructional help or simplified representation on feedback, in addition to the correct answer or right/wrong knowledge of results.

7. **Attribute Matching.** Example displays should include matched nonexamples (i.e., nonexamples that are as similar as possible to, and are presented simultaneously with, the examples that are provided). The nonexamples should be
selected in such a way that it enhances the student’s ability to discriminate between characteristics that are relevant and those that are not relevant. Practice displays should be randomly sequenced and unmatched to nonexamples. A matched example-nonexample pair for which the student is asked to classify which is the example and which is not, or is asked to recognize which is the correct execution of a procedure and which is not, provides an unintentional prompt for the student. Therefore, it is desirable in most cases to present instances in the practice mode in random order so as to avoid the potential presentation of matched examples and nonexamples.

8. **Instance Sampling.** Instances in both example and practice displays should be divergent, range in difficulty, be presented in an easy-to-difficult sequence, and/or include a variety of representation forms. For most instructional situations, it is adequate to make a conscious effort to informally include a range of difficulty and a range of divergence rather than to systematically sample all the potential instances.

These propositions can be a guide in the designing and development of instruction, and also allow the designer to evaluate the effectiveness and efficiency of his or her instruction even before experimenting with it. The strength of CDT is that it allows us to quantify and predict the degree of effectiveness and efficiency of instruction, by stating these propositions in question form and defining conventions for assigning index values for various questions or sets of questions for a given segment of instruction.

### Consistency of Instruction

The propositions of CDT are valid only within certain boundaries and contexts. The display of PPFs with their rich elaborations must be consistent with the goal and objectives of the instruction. Otherwise the rich instructional presentations would be fancy and glamorous displays without much real substance. CDT provides sets of the conditions and boundaries in which the propositions can function in a right way and for right reasons.

CDT prescribes that instructional display or presentation should be consistent with the goal or objectives of the instruction no matter whether the goal or objectives are stated as a part of instruction or not. In most cases, the instructional designer does not state the objectives as part of instruction. Then the posttest is the operational expression of the intended objectives, and the instruction must provide consistent and valid information the learner should know on the test.

The task-content classification table (Figure 2) allows an instructional designer to classify the kinds of instruction he is working with. This classification provides a means for judging how the designer can make his presentation to be consistent with the objectives and test items.

**Figure 2: Task-Content Classification Table for classifying instructional objectives/test items and presentation.**

<table>
<thead>
<tr>
<th>TASK LEVEL</th>
<th>Content Type</th>
<th>Fact</th>
<th>Concept</th>
<th>Procedure</th>
<th>Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use</strong> Generality</td>
<td>Read the following paragraph: Identify the sentence that best represents the emotion of the speaker (Identify or Classify)</td>
<td>Change the following active voice (newly encountered) into passive form. Conjugate the following verb into past tense.</td>
<td>Why are sounds always acquired before fricatives in child language acquisition? Why do children say ‘mama’ or ‘papa’ instead of ‘koko’ or ‘lulu’? (Explain why or predict)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remember</strong> Generality</td>
<td>What are the characteristics of verb final languages? According to the dialogue, why was the girl upset?</td>
<td>Describe the steps of changing active voice to passive.</td>
<td>In conjugating verbs into past tense in XX language, why should the correct procedures be followed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>What is the definition of topic? (State or define)</td>
<td>List in correct order the steps necessary to change the active voice to passive voice.</td>
<td>Which of the following explains the reason your textbook gives for XX language being less prominent in passive voice?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remember</strong></td>
<td>Who invented the Korean Alphabet? What is ‘school’ in Chinese?</td>
<td>Translate the following sentence into Chinese: Which is the past participle of the verb ‘go’? Make a complete sentence by typing in the correct sequence of the following scrambled phrases.</td>
<td>Generally, how do the past tenses in English incorporate the past participle?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>How do you say ‘Good morning’ in Japanese? (Recall or recognize)</td>
<td>What are the steps for changing the verb ‘to study’ into the past participle?</td>
<td>Is xx language different? Explain why the post-positions discussed in the class may or may not be used in the following sentences.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples (May not be used in the exam)

It is common experience that although an objective of typical language instruction is often at the use-generality level (e.g., the student should be able to understand the directions to reach a certain destination given by a native
There are at least four different aspects of instruction that influence student performance. These include: (1) ways of organizing the instruction, such as sequencing and formatting the subject-matter content; (2) ways of delivering the instruction, which is usually a matter of media selection; (3) ways of motivating students; and (4) ways of managing the interaction between the student and the instruction. Instructional organization can be further divided into two categories: (1) ways of organizing the instruction on a single topic and (2) ways of organizing instruction that interrelates sets of
topics such as sequencing the topics, the use of overviews, advance organizers, and various kinds of sequencing (Reigeluth 1979; Reigeluth and Merrill 1978). CDT only analyzes the organization of the instruction on a single topic.

Even though CDT covers only one narrow aspect of instruction, its detailed operational procedures provide an instructional designer to produce effective instructions—within its limited domain.

**Conclusion**

The contribution of CDT in instructional design is that it provides not only the step-by-step operational procedures, but also practical procedures for analyzing and quantifying the quality of instruction in relation to its objectives and test items. It provides a checklist for the designer to diagnose and quantify the effectiveness of the instruction without any extensive formative evaluation. Using CDT as a design guide provides instruction that should already (i.e., without formative evaluation) have a high degree of effectiveness because of the previous validation of most of the principles that constitute CDT. However, it is recommended that the instruction designed according to the principles of CDT be tested in a real world situation in order to validate a particular application of the principles in a particular setting. It should not be necessary, however, to conduct as extensive an evaluation or extensive revisions as would be required for a more intuitive approach to the design and development process.

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**Table:**

<table>
<thead>
<tr>
<th>TEST ITEM</th>
<th>TASK LEVEL</th>
<th>PRIMARY PRESENTATION FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Generality (Generality)</td>
<td>Tell Via Example (Example)</td>
</tr>
<tr>
<td>Remember</td>
<td>Paraphrased Generality</td>
<td>Question Via Example (Practice)</td>
</tr>
<tr>
<td>Remember</td>
<td>Verbatim Generality</td>
<td>Question Via Generality (Generality Practice)</td>
</tr>
</tbody>
</table>

*Figure 3: The task-primary presentation form matrix shows which primary presentation forms should be included in an instructional presentation in order for it to be consistent with its test item(s)*.

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1 Previous publications on the CDT referred to it as the Instructional Strategy Diagnostic Profile (Merrill et al. 1977), and the Instructional Quality Profile (Merrill, Reigeluth, and Faust 1979).

**Author’s Note:** This is a revised version of the paper read at the Seventh International Conference on Computers and Humanities, 26-28 June 1985, Brigham Young University, Provo, Utah. The author expresses his appreciation to Dr. M. David Merrill, Professor of Instructional Technology at the University of Southern California, for permission to write a paper about his CDT.

**Bibliography**


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Figure 4: Sample of Presentation Adequacy Rating Form Conveying Generality Criterion and Feedback Comments

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