Chapter XVII
The Pervasiveness of Design Drawing in ID[1]

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ABSTRACT

This chapter is a survey of the literature of ID to look at the breadth and usage of design drawings in this discipline to better understand the emerging use of VIDLs to improve designs. To conduct this research, we sampled several ID textbooks, ID journals, software, and case studies looking for examples of design drawing. Design drawings found were then categorized using Gibbons' (2003) seven ID layers as a taxonomy to understand the drawings' purposes.

We did not find the same pervasiveness or level of self-awareness as found in other design fields. Examples of design drawings were found, but were somewhat rare. Furthermore, we discovered that those examples we found tended to document only two of Gibbons' seven layers, indicating narrow application. We believe this gap represents a serious shortcoming in ID, indicating a lack of tradition, skill, and standards for visual representations of design except in limited ways.

At present, design drawing is a rare but growing phenomenon in ID, which, when fully understood and implemented, can only benefit the practice of ID.

INTRODUCTION

This chapter applies a layered concept of Instructional Design (ID) architecture described by Gibbons and Rogers (in press) to a taxonomy of design drawings described by Stubbs (2006) to produce a refined category system for describing the use of drawing and sketching in ID. The value of doing so is dramatized by Stubbs, who compares the use of design drawing in ID to its use in other design fields, detecting a large disparity. If Stubbs' analysis is correct, then designers in other fields have a much richer tradition of the use of drawing in design and a literature that shows a much higher level of self-awareness in the use of drawings during design than most instructional designers would expect.

Design drawing might be considered the primitive of Visual Instructional Design Languages (VIDLs). In this chapter we hope to understand where we are with this basic form of VIDL to better understand where we are going.

Though instructional designers excel in the use of drawings of many kinds in their *produced* designs, it would appear that they lag behind other design fields in exploiting the value of drawings and sketches while *designing*.

This deficit has important consequences for the economics, quality, and quantity of instructional designs. Whereas other design fields have begun to capitalize on the power of computers as a design tool, instructional designers seem to be more at the mercy of the tools and design interfaces created for use by others who have more vibrant economies, such as Web and software design. Early attempts to create tools to express designs in the instructional designer's vernaculars appear to have been swallowed up in the success of other design fields, notably the Web and Web development tools (Fairweather & Gibbons, 2000). Only recently has interest in the authoring of learning objects revitalized interest in design interfaces that emphasize ID structures, a trend that we hope will persist and broaden.

The value of the computer to design lies in its ability to take part in routine and mundane decision-making. Successes in computer-aided design have come largely from the ability to describe a design problem (or some portion of a design problem) in terms that can be translated into computer languages. For instance, the design of an architectural column can be translated into sub-problems for the design of the capital, the shaft, and the column base (Mitchell, 1990). If only the shaft sub-problem could be expressed in computer terms, then that portion of the design could be given computer support, and the remaining sub-problems would depend entirely on human decision-making. By the same reasoning, if only portions (sub-problems of sub-problems) of the design of each of the capital, shaft, and column base could be expressed in such terms, then the design of each of these would require human effort and decision-making, supplemented by some degree of computer assistance. This is the principle today of popular development systems for Web and software design. The involvement of the computer—which is capable of making numerous routine decisions very rapidly and dealing with representation issues at the same time—creates an economic lever. More quantity at higher quality can be produced more rapidly—cheaper, better, faster. And as languages for problem description and solution improve and become more nuanced, the quality and sophistication of the designs improves. This is exactly what has happened to the design of computer chips over the past thirty-five years. Chips designs today are created to human specifications with human decision-making concentrating mainly on high-level design issues. As a result the economics of computer chip design have changed so that a return to hand-drawn circuit design would be an expensive luxury.

This chapter addresses how ID problems can be described in terms of design languages (some portion of which may be translatable into computer languages). It begins by describing research by Stubbs (2006) on the use of design drawing by instructional designers. Stubbs conducted a review of ID literature, and categorized the drawings he found there according to the layers described by Gibbons and Rogers. Stubbs discovered the disparity we have already mentioned between the "level of interest in design drawing between ID, and other fields of design" (p. x). He found that, though in the field of design studies there is strong interest in design drawing, there is not a corresponding interest and self-awareness of the use of drawing in the literature of ID.

According to Stubbs:

The general design studies literature has both theoretical and empirical studies on the subject of design drawing. In this literature, design drawing is considered an important, even vital part of design thinking. It is thought of as a design language, which comes in a variety of distinguishable forms, and accompanies and contributes to the design process as it progresses through various stages of development. Studies in this literature show how the intentional ambiguity of design drawing provides space to the designer for creativity and innovation, invoking a kind of dialogue between the designer and the design, which is deemed essential to the design process…. By contrast, the literature of ID has nothing like this level of consideration for design drawing. Instead, the few available articles in the literature of ID touching on design drawing are about proposed notation systems. Evidence of design drawing in the practice of ID as seen in the literature finds that, when it does appear, it is most often concentrated in two aspects of ID identified with Gibbons' content and strategy layers…. To say that there were no examples of design drawing in ID would be hyperbole. However, considering how little was found and how narrowly focused it was, it prompts the question, "What might ID be missing by its lack of attention to this language, so valued in other fields of design?"(p. 85–86. See also chapter 3).

Stubbs notes McKim's (1980) observation "that designers with versatility and skill in graphic languages have an advantage, which may apply to instructional designers as well" (p. 134). McKim postulates that "not only [will designers]…find more complete expression for their thinking but also [they will be able to] re-center their thinking by moving from one graphic language to another" (p. 134). On this basis, Stubbs proposes that design drawing in ID "deserves a thorough examination" and presents the typology of design drawings, described below, that distinguishes six types of drawing that commonly appear in the literature of the field. Only one of these six types is considered design drawing.

Next, the chapter uses the layered ID architecture proposed by Gibbons and Rogers (in press) to categorize design drawings by function. This architecture draws on concepts from many design fields, showing that designs in those fields have a layered architecture that decomposes design problems in functional terms. Baldwin and Clark (2000) describe how this principle of decomposition lies at the economic center of the modern computer industry, making possible design modularity. Gibbons and Rogers demonstrate that layering applies to instructional designs as well, with the benefit that the problem thus described can be solved in terms of existing design languages, most of which are derived from instructional theory or proven design practice.

EVIDENCES OF DESIGN DRAWING IN ID

The experience of many instructional designers strongly suggests that design drawing is a part of ID. However, this chapter will show that ID does not appear to have the same tradition for design drawing, especially during the early phases of design, as is found in other design fields. For this review, evidence of design drawing in ID was sought in several sources: a sampling of ID textbooks, journals, software, and case studies were examined. The ID literature for research about design drawing in ID was also searched. With some notable exceptions, very little was found.

To facilitate the study of design graphics, a typology was created to identify the types of graphics found in ID literature. This section describes this typology as a means to categorize graphics of interest to this study. Gibbons' instructional design layers are then used to provide further sub-categorization of one of the types of graphics found in the literature.

A Typology of Images

A variety of types of illustrations can be found in the literature of ID. Some are design graphics, but many are not. This typology of images has been devised to aid in distinguishing those that are from those that are not. A sampling of the literature of ID was scanned for graphics, and then those graphics found were categorized into one of five types based on their apparent intent:

1. **Design graphics:** Design graphics illustrate some aspect of the design of a specific piece of instruction for the purpose of planning or building that instruction.
2. **Content graphics:** Content graphics are part of the instruction delivered to learners that aid or support learning.
3. **Reporting graphics:** These graphics are used to illustrate or report the outcomes of research.
4. **Illustrations of ID models:** Graphics of this sort are illustrations that represent processes of design or construction of instruction. Diagrams of the popular ADDIE or ISD processes fall into this category.
5. **Instructional models & learning models:** These graphics include illustrations of the components of instructional theories or learning theories and the relationships among them. They are sometimes not differentiated from ID models (type 4).

The principal difference among these types is intent; the surface form may not be the discriminator. For example, it is possible to imagine a graphic, whose intent is unclear without the accompanying explanation. The mere existence of a diagram with circles and boxes connected with lines would not be enough to determine a graphic's purpose.

Let's examine each of these different types of graphics found in the research literature.

Figure 1 is an example of a type 1 graphic. It is clearly related to some specific piece of instruction, charting the flow of procedures for training a specific piece of content. It may have been created to help a programmer or developer understand what was supposed to happen in this instruction.

Notice the specific content in the graphic (Kalyuga & Sweller, 2005) (Copyright © 2005, The Association for Educational Communications and Technology [AECT] Used with permission.)

Type 1 graphics have information, either in the diagram or in the accompanying context, that ties them directly and clearly to the design of a specific piece of instruction. They may refer to specific content, as does Figure 1. They illustrate the structural elements, flow, process, information chunking, or some other aspect of the specific instructional design. To determine if a graphic is of type 1, ask, "Was this graphic representation created to assist in the creation of specific instruction?"

Type 2 illustrations are distinguished from type 1 by being part of the content of the instruction, rather than part of the design. That is, they are presented to the learner. Figure 2 was part of the content of experimental instruction trying to determine the difference in value between using mimetic icons versus standard square icons in a content graphic.

Computer screen shots of finished computer assisted instruction (CAI) are common illustrations

Figure 1. An example of a type 1 graphic from ETR&D

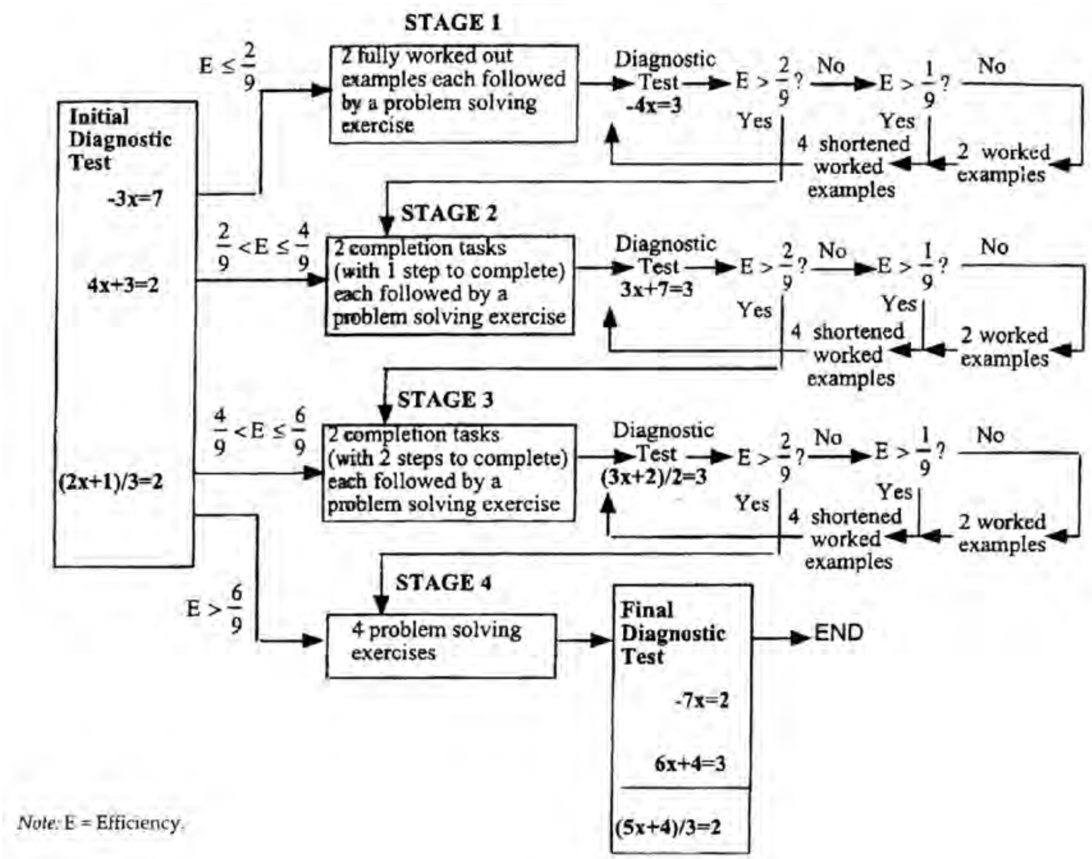


Figure 2. An example of two type 2 graphics from ETR&D (Griffin & Robinson, 2005) (Copyright © 2005, The Association for Educational Communications and Technology [AECT] Used with permission.)

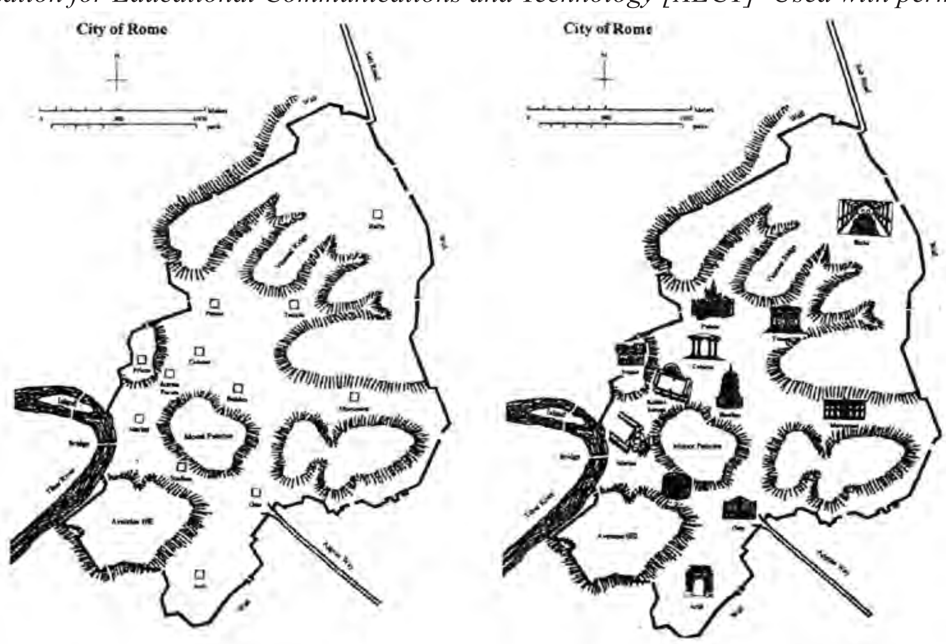
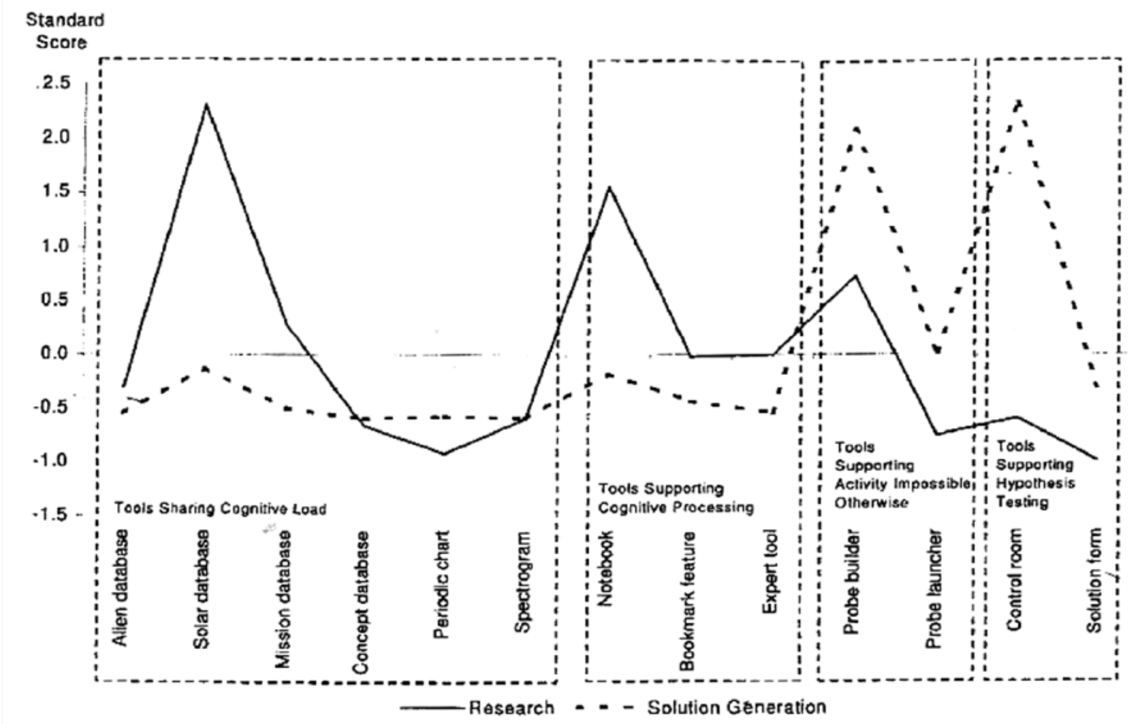


Figure 3. An example of a type 3 graphic from ETR&D (Liu & Bera, 2005) (Copyright © 2005, The Association for Educational Communications and Technology [AECT] Used with permission.)



in the sources reviewed. These screen shots should be considered type 2. To decide if something is type 2, ask, "Was this graphic representation part of what was presented to learners during instruction?"

Type 3 graphics are used to illustrate the outcomes of research. They are often employed to help make statistical results more transparent to the reader. Bar graphs, pie charts, line graphs, etc., are common, though they are not limited to these. They are distinguished from type 1 because they illustrate the results of evaluation or research rather than the proposed design of a piece of instruction. Figure 3 is a typical example of type 3 graphic which supports a report on outcomes of research.

To determine whether a graphic representation belongs to type 3, ask, "Does this graphic help report the results data or other outcome of the evaluation or research?"

Type 4 diagrams are used to illustrate models of design processes, what Reigeluth (xxxx) calls an "instructional-design process" (p. 13). Figure 4 shows Dick and Carey's model for the systematic design of instruction—a classic example of an illustration for a design process. The purpose of type 4 graphics is to help the reader understand a design process model, i.e., how to design or create instruction.

To clarify whether a diagram belongs to type 4, ask, "Does this graphic illustrate a design process or theory about how instruction ought to be designed?"

Finally, type 5 diagrams illustrate instructional models and learning models. Figure 5 is an example of a type 5 diagram. Note that it describes or illustrates a general principle of teaching or learning and is not specific to a particular piece of instruction nor does it describe a process by which instruction is created. This type of diagram would normally be illustrating an instructional theory or learning theory.

Figure 4. Dick and Carey's (1990) model for "Systematic design of instruction"

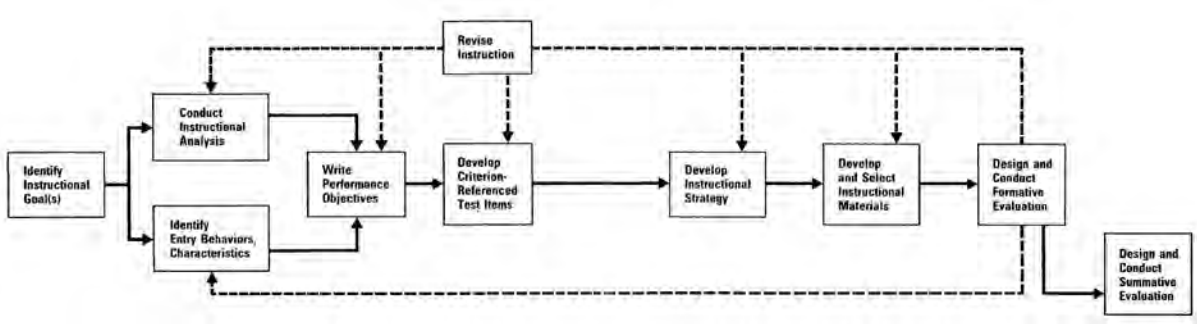
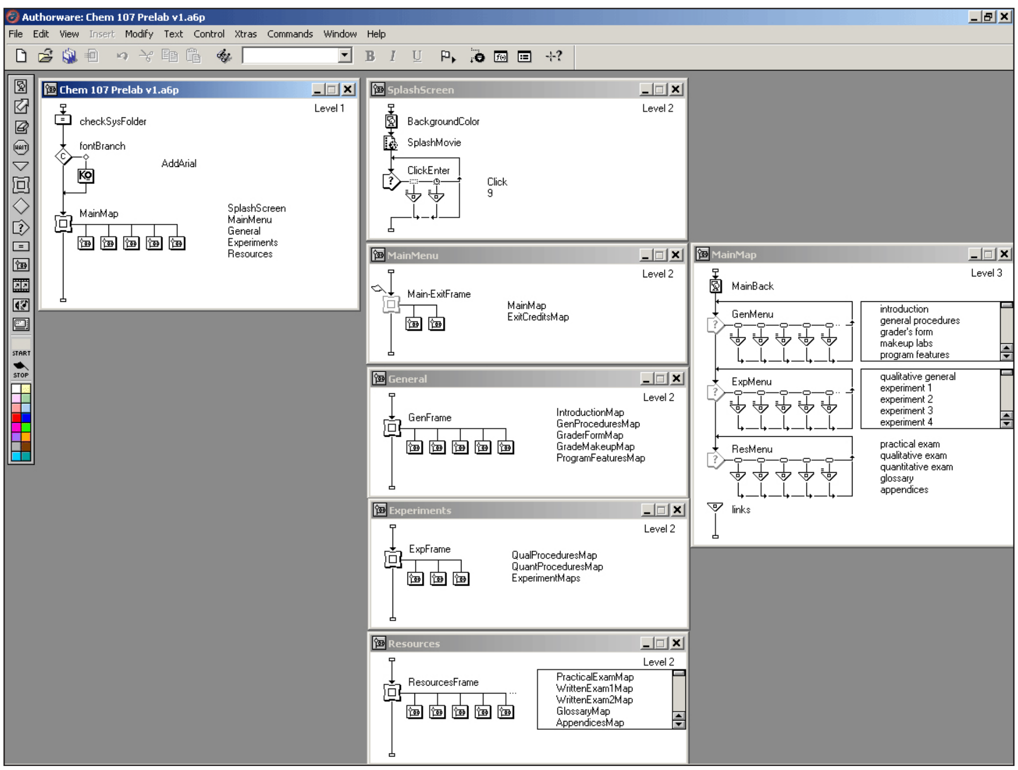


Figure 5. An example of a type 5 graphic from ETR&D



Design theories and models (type 4) are often confused or conflated with learning and instructional theories and models (type 5). May (2006) distinguishes between design theories and learning or instructional theories by noting that design theories pertain to how someone designs an instructional product to achieve certain objectives, whereas learning theories pertain to how someone receives, processes, and remembers information. Though similar in some respects to type 4, design process model diagrams, type 5 diagrams can be distinguished from the others by asking, "Does this graphic illustrate a theory of learning or a theory of instruction?"

While this typology covers the majority of illustrations one might expect in research about instructional design, other kinds of images occasionally occur. For example, a photograph of the principal of a school where an intervention took place, is probably not easily placed into any of the types proposed.

Extending the Typology of Type 1 Design Graphics with ID Layers

Once graphics have been established as type 1, design graphics, is possible to extend the typology to identify and distinguish them from each other. This sub-level of categorization provides the ability to see how widely design drawings are used throughout the design process.

This sub-categorization is accomplished by adapting a concept put forth by Gibbons (2003) called instructional design layers. Gibbons has observed that instructional design often takes place as the design of several interrelated layers. Design of each layer can be considered separately from the other layers, providing an important modularization to the design effort. The design of each layer is expressed in design languages, and these languages define the scope of designers' thinking. Gibbons' instructional design layers are:

- Content
- Strategy
- Control
- Message
- Representation
- Media-logic
- Data management

At the content layer, the designer defines the units of content segmentation, determines the method of content capture, and defines the kind of content elements that will be gathered. The design problem in the strategy layer consists of several interrelated sub-problems concerned with structures of time, goals, sequence, activity, physical setting, and social relationships are decided. The design problem within the control layer is the means of communication of messages from the learner to the source of the learning. The message layer determines the types of instructional messages, how they are composed, and how they are generated. The representation layer is the selection of media types, the selection of media, its generation, and the rules governing its structure and display. The design problem within the media-logic layer involves the description of execution structures that enact the representation and interactions. The design problem at the data management layer is to plan the capture, storage, analysis, aggregation, interpretation, and reporting of data produced during instruction.

To determine the pervasiveness of design drawing in ID, this typology and its extension of type 1 graphics by ID layers has been applied to a number of sources to discover and analyze examples of design drawing in ID. These sources are discussed below.

ID LITERATURE SAMPLING

A sampling of common texts in the field of ID was searched for images. Images found were then filtered through the typology above to identify examples of design drawings, type 1, in the texts. The texts included in this review are common, well-known textbooks about instructional design. Included in this review are the following textbooks: *The Systematic Design of Instruction* (Dick & Carey, 1990), *Principles of Instructional Design* (Gagné, Briggs, & Wager, 1992), and the two volumes of *Classic Writings on Instructional Technology* (Ely & Plomp, 1996). An argument could be made to bring in other texts not included here, but these are an adequate representative sample for our purposes.

The original edition of Dick and Carey's book from the late 1970s is the source of the first "Dick and Carey model" of instructional design known to nearly every instructional design student of the last thirty years. This model is particularly helpful to inexperienced or beginning instructional designers because it provides a complete systematic approach to the process of instructional design. (This review uses the 1990 edition of the text.)

The familiar blue and violet book by Gagné, Briggs, and Wager (1992) can be found on the bookshelf of nearly every instructional designer trained in the 1990s. Its presence on the bookshelves of colleagues often means that it was purchased as a class textbook, but it was kept for its ongoing value as a reference. This textbook provides a rational basis for much of the practice in instructional design, based in cognitive psychology and information processing theory.

The two-volume set from Ely and Plomp (1996) is a collection of classic literature in the field of ID. As such, it has value for both its historical reach, and the breadth of coverage. These volumes of classic articles reveal some of the roots of the field of instructional technology in audio/visual production and distribution, about which many of the papers are concerned.

For the purpose of this review, three respected ID journals were also scanned for graphics. Graphics found were categorized by the types above to discover any type 1, design graphics. The journals surveyed included: *Educational Technology Research and Development* (ETR&D), *Interactive Learning Environments* (ILE) and the *Journal of Educational Technology Systems* (JETS). It was felt that this combination of journals gave a sufficiently broad cross section of the field to effectively represent graphic communication in ID research literature.

ETR&D is a bi-monthly research publication of the Association for Educational Communications and Technology (AECT). It contains sections on both research and development, as well as book reviews, international reviews, and research abstracts. AECT has a historical connection to schools and libraries (especially audio/visual departments) and has good relationships with the faculty and students from universities that have degrees in instructional technology. AECT is an international organization, but its roots are American, and the majority of its members are from the United States. Articles in ETR&D tend to reflect this orientation. For this study I looked at all the graphics in volume 52 (2004), one full year.

ILE is an international journal published in Europe about the impact of technologies (the Internet, groupware, multimedia, etc.) on education, training, and life-long learning. The journal includes articles that cover both tools and organizational support required for authoring and implementing courseware. ILE is published three times a year; one publication contains two volumes. I reviewed volume 12, numbers 1 and 2 (a single publication), volume 13, numbers 1 and 2 (also a single publication), and volume 13, number 3. This covers roughly a year and one third.

JETS is published by Society for Applied Learning Technology (SALT). This quarterly journal deals with systems in which technology and education interface with special emphasis given to the use of computers as a component of education systems. Members of SALT tend to come from the ranks of government and military, industry, and education, in that order. JETS reflects this priority in the types of articles it contains. For purposes of this study volume 33 (2004-5), covering one year, was reviewed.

Instructional design software was also considered. Since the early days of multiple slide projectors driven by cues on a sound track, multimedia has been explored as an instructional medium. Since the computerization of these tools, there have been graphic user interfaces among instructional multimedia authoring tools. PCV3 from Control Data and forms of visual PILOT (a computer-assisted instruction language; the acronym stands for Programmed Instruction, Learning, or Teaching) are examples of these. Of all these systems, Authorware enjoyed a unique position by being popular as a general-purpose multimedia authoring system as well as an instructional design solution, in spite of the fact that it was expressly developed to serve the needs of ID. Though they are very popular with instructional designers, Macromedia Director and Flash, are not reviewed for this study because they are general-purpose multimedia authoring tools, though they are used extensively in the production of instructional materials.

Authorware was selected for discussion in this section because it is by far the most popular ID-specific tool and it uses a graphic user interface that mimics traditional flowcharting familiar to instructional designers and others.

It may be argued that ID textbooks and journals would not be a fruitful source of ID graphics because they are mostly concerned with general theory and broad explanations. If that were true, then one particular kind of study would be more apt to provide evidence of design drawing in instructional design: case studies.

Indications that cases may be a fruitful source of examples of design drawing in ID can be found in a popular set of competencies for instructional designers called "Competencies and Skills for Instructional Designers" (Analysis & Technology, 1995) of this list of competencies suggests that instructional designers be competent in the ability to:

- Develop flowcharts to identify learning events at the frame specific level using standardized symbology
- Develop storyboards using a template appropriate to the needs of the project

Case studies may be found in journal articles, dissertations, and books. For purposes of this study, one book of ID case studies, plus five additional case studies were reviewed.

The book of ID case studies reviewed is *The ID Casebook: Case Studies in Instructional Design* (Ertmer & Quinn, 2003) which is a compilation of 36 instructional design cases for use as practice by beginning instructional designers. Five additional case studies, four dissertations and one research article, were also reviewed. Most of the additional case studies were found by searching Doctoral research in educational technology (2005) as well as Digital Dissertations (University Microfilms) and ISI Web of Science (Institute for Scientific Information), searching for the term "case study" in the title of instructional design articles and dissertations. Case studies were considered that seemed to cover the instructional design of materials, rather than other cases (such as those about educational programs or processes), as it was thought that these would be the most productive sources of design drawing. The article is by Gastfriend, Gowan, and Lane (2001) and the dissertations include Ludwig-Hardman (2003), Hall (2004), and Twitchell (2001). Another dissertation, May (2006), was recommended by a colleague.

Although drawing as a method of design has been discussed in general literature of design studies since the 1960s and before (Jones, 1970), it has only recently become the object of study in ID. Initially, the search for ID literature about design drawing was frustrating—particularly with automated search tools. Any attempt to combine terms like "drawing," "graphic," or "representation" with "instructional design" or "instructional technology" invariably resulted in research titles that had to do with the use of visual media in designed materials (type 2), not for their design and development (type 1). However, by careful screening, a few studies were identified that seemed relevant. These are: some articles authored by Gilbert Paquette and others (Paquette, 1996; Paquette, Aubin, & Crevier, 1994; Paquette, de la Teja, Lundgren-Cayrol, Léonard, & Ruelland, 2002; Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006; that design language is presented here in Chapter 2.3) about proposed graphic notation systems for ID; and, an article by Figl and Derntl (2006) which discuss Visual Instructional Design Languages (VIDL). One of the VIDLs discussed in Figl and Derntl is Botturi's E^2ML. I will also discuss Botturi's (2003) dissertation on E^2ML in detail.

Results of ID Literature Review

Textbooks

For this literature review, three textbooks, Dick and Carey (1990), Gagné, Briggs, and Wager (1992), and Ely and Plomp (1996) were reviewed. All the graphics and illustrations in these textbooks were classified according to the typology discussed earlier into one of five types (or miscellaneous if they did not seem to fit any of the categories). This classification is presented in Table 1.

In two of the books, design drawings predominate, taking 42% in Dick and Carey (1990) and 62% in Gagné, Briggs, and Wager (1992). In Ely and Plomp (1996), design process model diagrams—type 4—lead, but with only 33% of the total. The difference in dominance of type 1 in the first two books versus type 4 in the last book can be explained by the differences in the purposes for which the books were written. The textbooks by Dick and Carey, and by Gagné, Briggs, and Wager are both intended as textbooks for the beginning designer. As such, they provide basic instructional design process information for guiding the novice instructional designer in her beginning work. This explains the prevalence of instructional design examples represented by these design drawings. Ely and Plomp, on the other hand, is a collection of miscellaneous papers from various sources brought together because of their seminal value to the field of ID. Because many of these papers propose instructional design models, the prevalence of type 4 model graphics should not surprise us.

The beginning of each chapter of Dick and Carey starts with a duplicate of the diagram of their model, with that chapter's step highlighted. Because the same diagram is repeated each time to aid in navigating the book, these model graphics were only counted once. Also, Dick and Carey contains a relatively large number of graphics categorized as "miscellaneous." Most of these miscellaneous graphics are depictions of proposed elements of their notation system for skills analysis. As such, they do not fit neatly into any of the categories.

The preponderance of design drawings or graphics in both Gagné, Briggs, and Wager, and in Dick and Carey was unexpected. Closer inspection of these graphics reveals that nearly all of these type 1 design graphics occur in the first third of both books, and all of them are examples of skills analyses. Each book sets forth a slightly different notation system for illustrating the results of skills analysis.

Viewing the skills analysis drawings through Gibbons' (2003) instructional design layers, discussed earlier I found that all the type 1, design graphics, in Dick and Carey, and in Gagné, Briggs, and Wager, fall within the content layer. As such, they are an important use of design drawing in their own right, but represent only a small fraction of the potential uses of design drawing in ID.

In summary, examples of design graphics in these textbooks are common, but limited to only one of Gibbon's seven layers of instructional design: content. If design drawing itself were considered an important aspect of instructional design work by these authors, I would have ex-

Table 1. Types of graphics found in three ID textbooks

	Type 1 Design	Type 2 Content	Type 3 Report	Type 4 Process	Type 5 Instr'l	Misc
Dick & Carey	28	2	6	6	9	15
Gagné, Briggs & Wager	16	4	1	4	1	0
Ely & Plomp	2	7	4	12	4	7

pected to examples illustrating other of Gibbons' design layers represented in this sample literature. Interestingly, content or skills analysis is often used as the starting point for instructional design, so the use of graphic as an aid to the start of instruction is noted.

Journals

For this literature review, three ID journals were reviewed. They are Interactive Learning Environments (ILE), Educational Technology Research and Development (ETR&D), and the Journal of Educational Technology Systems (JETS). All the graphics and illustrations in selected issues were classified according to the typology discussed earlier into one of five types. This classification is presented in Table 2.

The three journal titles that were sampled for this study show some variation from the results of the textbooks.

In these journals, many articles demonstrated or discussed specific instructional design projects. As a result, type 2 graphics (screen shots from instructional computer programs and other illustrations of content) predominated: in ILE 56%, in ETR&D, 31%, and in JETS, 48%.

In ETR&D, the balance between research and development articles is reflected in the balance between type 2, content graphics (31%), and type 3, report graphics (29%). JETS is similarly balanced between type 2 and type 3.

Type 1 graphics, while not the least common, are always in the minority. In ETR&D they were the smallest category, 2%; they are the third smallest category in both ILE at 14% and, in JETS, at 9%.

In summary, even more dramatically than in the textbooks analyzed, these numbers indicate the relatively light value placed on type 1, design graphics, in the journal literature of ID. Instead, we find a preponderance of type 2, content graphics, often, captured computer screens or graphics, used to illustrate reports about specific products.

Software

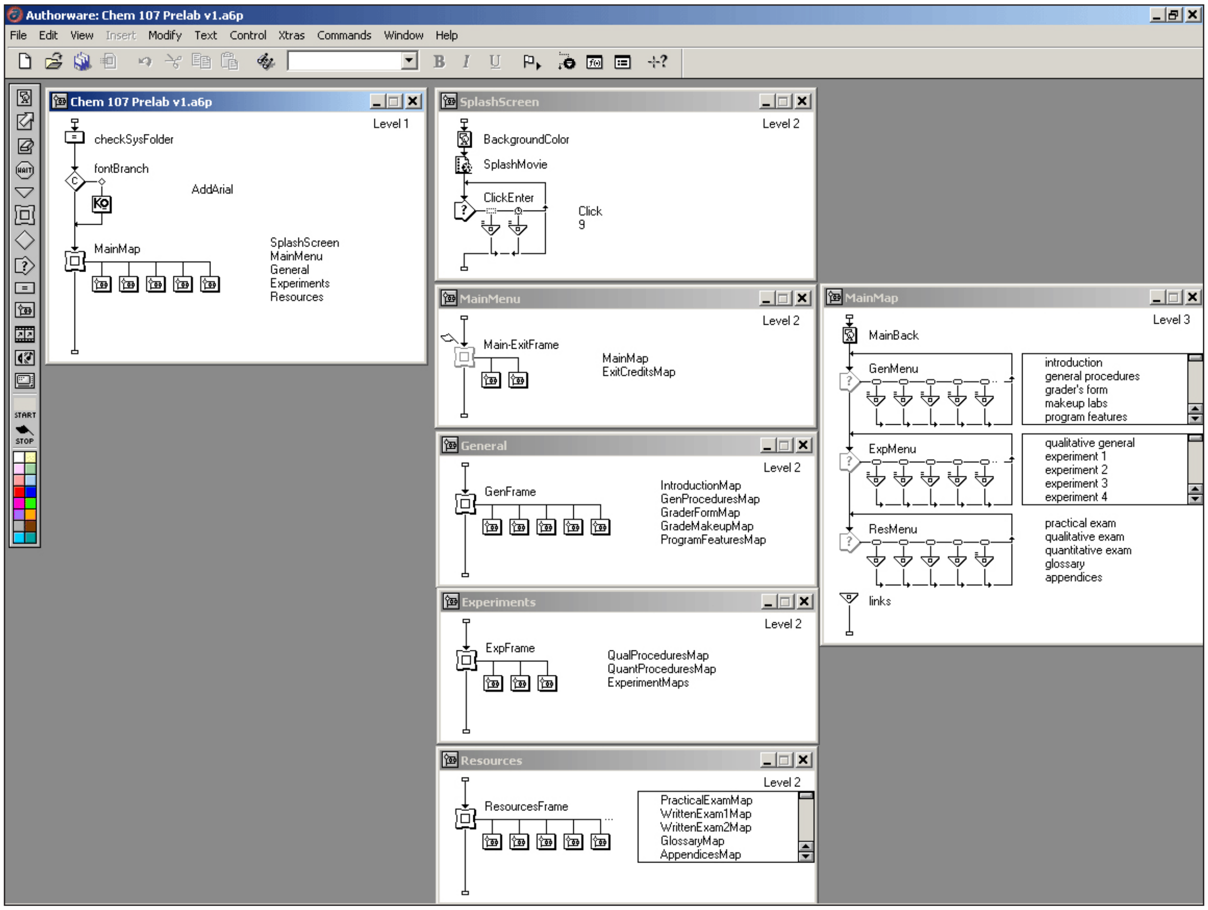
Authorware is the ID multimedia authoring software reviewed in this study. The original Authorware, called Course of Action, was created by programmer and instructional designer Michael Allen who had been working on Control Data's PLATO courseware. It was his intent to build a system that would require little or no programming to produce instructional courseware. (Wikipedia: Authorware)

To build a presentation in Authorware, the designer drags pre-defined behavior icons from a palette of behaviors onto a design window. Once in the design window, a behavior's specific attributes can be set. The behavior icons in the design window are connected into a visual flowchart called a flowline, which determines the sequence in which the behaviors are executed. Figure 6 shows several design windows with flowlines in them. Also note the palette of behaviors on the left side of the figure. Behaviors include display, MOTion, erase, navigation, interaction, calculation, movie, and others. The available behaviors have changed over the life of the product. When an Authorware presentation is executed, the behaviors play out their actions on the presentation window (not shown).

Table 2. Types of graphics found in three ID journals

	Type 1 Design	Type 2 Content	Type 3 Report	Type 4 Process	Type 5 Instr'l	Misc
ILE	11	46	7	14	3	0
ETR&D	1	13	12	8	4	4
JETS	5	30	26	2	0	0

Figure 6. Authorware presentation's behavior palette (far left) and several flowlines.



It is surprising that Authorware is one of the few ID products that uses a visual approach to design. The dragging of behaviors to the design window and connecting them into a flowline is a good example of a visual metaphor. Authorware's iconic, visual interface allows designers and authors to work more efficiently. The visual metaphor excels at providing the author the ability to see the flow of media-logic and to catch logical errors in thinking.

However, much of Authorware's functionality is not accessed visually, but by means of dialog boxes for specifying the attributes of behaviors and in other non-graphic ways, including a complete scripting language inside the application. Viewed through Gibbons' layers of ID we find that the flowline—the most graphic aspect of Authorware—is limited to Gibbons' strategy layer and media logic layer because it allows the designer to define the sequence of instructional events, and it directly affects the logic of execution. Visual means are also provided for composing the screen presented to users (the representation layer) but each screen must be composed separately—there is no way to compose families of screens through the visual interface (though it might be scripted in the scripting language). There are also ways to add control elements to the screen (addressing the control layer), but, except for their placement on the screen, the manipulation of these screen controls is not performed through the visual interface. Authorware does have some built-in student tracking capability (supporting the data management layer), but more than basic functions of this capability require scripting. Authorware has no provision for the content layer, or for the message layer to be addressed by the designer.

Case Studies

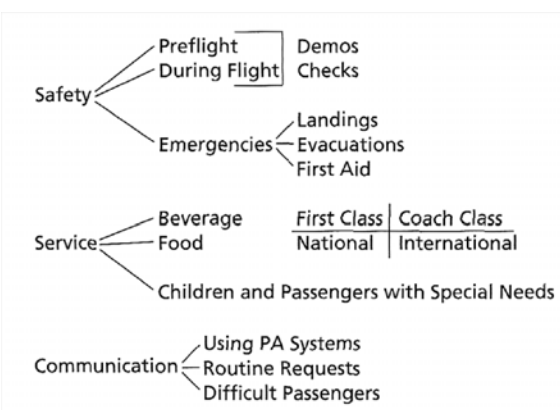
Of the six sources for case studies reviewed, only two illustrated significant examples of design drawing. In the other four, there was little or no evidence of type 1 design graphics (though several of them did have examples of types 4 and 5—graphics supporting instructional design process models and instructional or learning models).

The first source of ID case studies examined was Ertmer and Quinn's *The ID Casebook: Case Studies in Instructional Design* (2003). Ertmer and Quinn contains only one illustration of type 1, shown in Figure 7. It is the results of a skills inventory for flight attendants. Like the design graphics found in the textbooks, it addresses Gibbons' content layer.

Of the five additional case studies chosen, the research article (Gastfriend, Gowen, & Layne, 2001) and two of the dissertations (Hall, 2004; Ludwig-Hardman, 2003) contained no examples of design drawing at all.

The dissertation-case study by Twitchell (2001) contains in an appendix a copy of the design

Figure 7. Simplified job map for level 1 flight attendants (Ertmer & Quinn, 2003, p. 68)



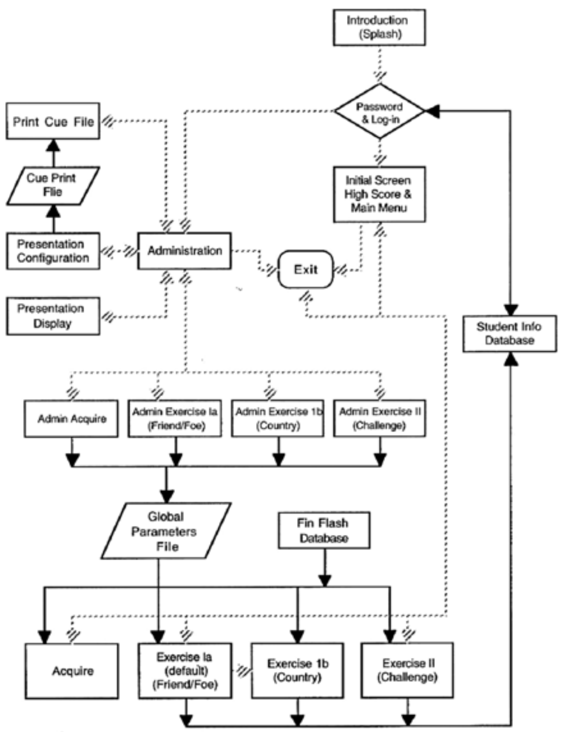
document for the courseware about which the case is written. Included in this design document are several instances of design drawings and representations. Here is a sampling:

1. A structural perspective: component parts (a venn-diagram-like illustration, with a circle and squares representing instructional components), p. 199.
2. A data-flow diagram, p. 200.
3. A logic & data-flow diagram, p. 202.
4. Several tables containing important data.
5. A rough screen shot of the initial screen, p. 214.
6. Several other rough (wire-frame?) screen shots, pp. 10, 11.
7. A flowchart of instructional logic for a drill, p. 234.
8. The instructional flow of the program, p. 237. (see Figure 8)
9. A screen shot (more refined than previous screen shots, but still not final) + pull-down menu items, p. 240.
10. Additional screen shots, pp. 242, 244, 245, 247, and 249.

These figures comprise a fairly broad representation Gibbons' ID layers. For example, the rough screen shots (items *e, f, i,* and *j*) are intended to guide the developer in the production of user-interface screens. As such they are clearly illustrative of the representation layer in the abstract, but probably also contain elements of the content and message layers as well. Item *a* is a broad view of the strategy layer as it applies to the entire piece of courseware; *g* is an example of a narrow view of one component of the courseware at the strategy layer. Item *h*, shown in Figure 8, illustrates aspects of both the strategy layer as well as the media-logic layer.

Another example of a case study is a dissertation by May (2006) which analyzed the use of Gibbons' (2003) Model-Centered Instructional Design theory by a team of instructional design-

Figure 8. Program instructional flow from Twitchell (2001)



ers tasked to design an instructional simulation. May carefully transcribed design sessions, and analyzed photographs of the rough design sketches drawn on the white board during design sessions. One of these photographs is shown in Figure 9. Many of the features of design drawing, are apparent in May's study

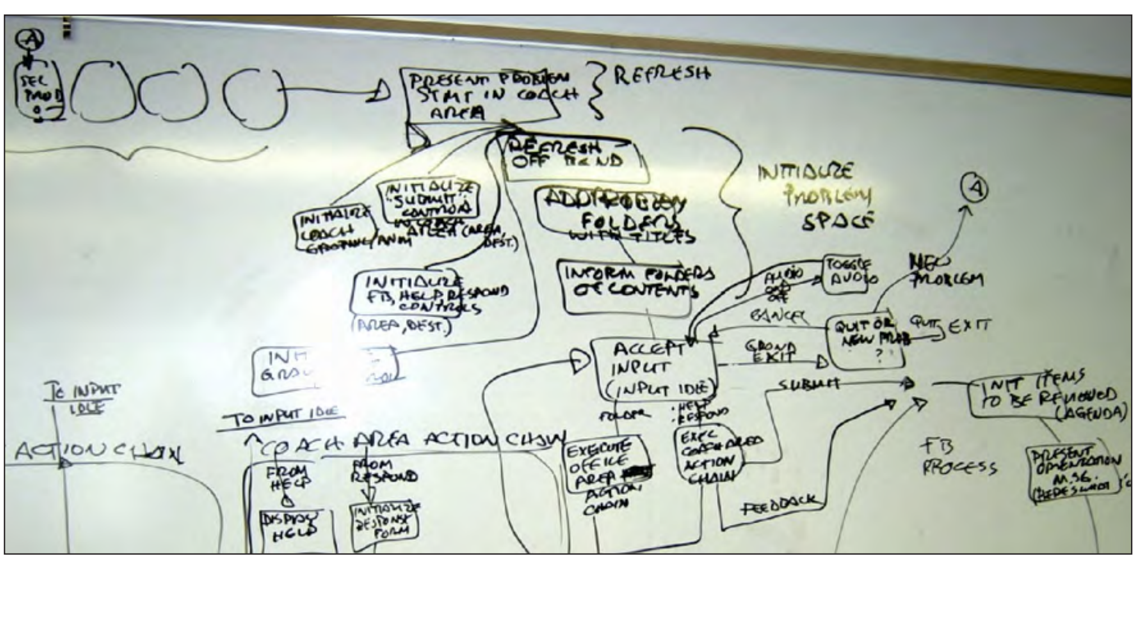
May's study was unique among the case studies that we encountered in the depth to which he analyzed the design process. Parallels between the general field of design and ID became clear in May because of his careful and thorough reconstruction of events and words. May's study is a wonderful window on the ID process in general and model-centered instructional design in detail.

To summarize, only two of the case studies reviewed gave insight in the role of design drawing in ID. The fact that I found so few speaks to the point that design drawing is not commonly discussed in ID at it is in the general design literature.

ID Literature about Design graphics: VIDLs

Our search uncovered three important sources of research on the topic of design drawing in ID. They are an article by Figl and Derntl (2006), a dissertation by Botturi (2003), and the research of Paquette, et al. (Paquette, 1996; Paquette, Aubin,

Figure 9. Example design drawings from May (2006)



& Crevier, 1994; Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006). These three sources are reviewed below. They are part of an increased interest in Visual ID Languages (VIDLs) (Boot, 2005; Schatz, 2003; Seo & Gibbons, 2003; Waters & Gibbons, 2004).

One example of this increased interest is the report of Figl and Derntl (2006), comparing the value of three VIDLs for the design of blended learning courses. What all these VIDLs have in common is their connection to the concept of learning objects and the SCORM (sharable courseware object reference model) standard. The three VIDLs compared are E^2ML (educational environment modeling language), PCeL (Person-centered e-learning), and EduWeaver.

E^2ML, a VIDL by Botturi (2003) is a semi-formal modeling notation for creating and documenting instructional designs. Its notation is similar to the unified modeling language (UML) used in object-oriented computer programming, substituting learning objects for computer-code objects. PCeL is founded on the person-centered philosophy of Carl Rogers (1983) but related to Alexander's (1979) concept of architectural pattern languages. PCeL includes a library of instructional patterns, modeled in UML activity diagrams, which serve as templates for the creation of instructional instantiations. EduWeaver is a Web-based courseware design tool that uses a modeling framework for grouping and sequencing learning objects into cohesive lessons, modules, and courses into its own visual format.

Of these three, Botturi's E^2ML can notate the widest variety of instructional constructs (see also Chapter 7). Botturi (2003) describes the intent of E^2ML as a kind of blueprint for instructional designs, allowing all stakeholders in an instructional design effort the ability to agree on details of design. His goals for E^2ML are to provide a notation system that will visually support design and development, document a design, and support evaluation.

While Chapter 7 of this handbook presents a more lightweight version of E^2ML , its original presentation, in 2003, proposes a wider set of interrelated diagrams. One of the principal strengths of E^2ML is indeed the many varied types of diagrams that can be used for various purposes. This flexibility comes from adapting a majority of UML's views to instructional design purposes. Botturi proposes several types of ID diagrams, shown in this list of diagrams (Botturi, 2003, p. 82) below:

1. Goal Definitions
   a. Goal statement
   b. Goal mapping
2. Action Diagrams
3. Resource Lists
   a. Role and actor list
   b. Location list
   c. Tool list
4. Overview Diagrams
   a. Course breakdown statement
   b. Dependencies diagram
   c. Activity flow

Figures 10, 11 and 12 are examples of a few of these types of diagrams. Figure 10 is an example of a goal map (item 1b on Botturi's list, above), showing dependencies among instructional goals. It was produced following the specifications of the QUAIL model, a sub-model of the original E^2ML specification. The symbols on the diagram labeled "G1," "G2," etc., represent different goals, Figure 11 is an example of an action or activity diagram (item 2 from Botturi's list). Note the goals which this instructional action is supposed to address, listed along the right side. Figure 12 is an activity flow diagram (item 4c on the list above), "A1," "A2," etc., are the identifiers for specific activities and the diagram shows their order of occurrence. All of the various types of representation in E^2ML are related to design, and fall under type 1.

While E^2ML's many types of diagrams give it broad coverage, nearly every diagram can be related to Gibbons' strategy layer in one way or another. However, most diagrams also contain elements for multiple layers and integrate those layers together. For example, the goal mapping diagram (item 1b from Botturi's list of diagrams above; see Figure 10 for an example) as well as his Dependencies diagram (item 4b from Botturi's list) address Gibbons' content layer as well as the strategy layer. E^2ML's action diagrams (item 2 from Botturi's list; see Figure 11 for an example), sophisticated tables of information, document some aspects of Gibbons' control layer, as does the Activity Flow diagram (item 4c from Botturi's list; Figure 12 is an example). Despite the preponderance of connections to the strategy layer, many of these diagrams integrate support for other layers as well.

Botturi's goal for E^2ML is that it serves as a means for detailing instructional designs with a high level of specificity like the finished blueprints in architecture, or the detailed orthographic projection drawings in engineering. E^2ML is being used to provide unified curricula among schools in Switzerland with different languages and cultures. Its high level of specificity allows it to do this. E^2ML portrays the final, detailed outcome of design thinking, not the process by which it occurred, much like the design document examples found in Twitchell's (2001) case

Figure 10. An example of an E^2ML goal mapping diagram showing dependencies (Botturi, 2003, p. 94)

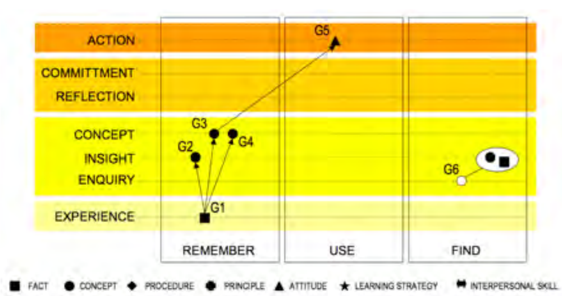


Figure 11. An E^2ML action diagram (Botturi, 2003, p. 98)

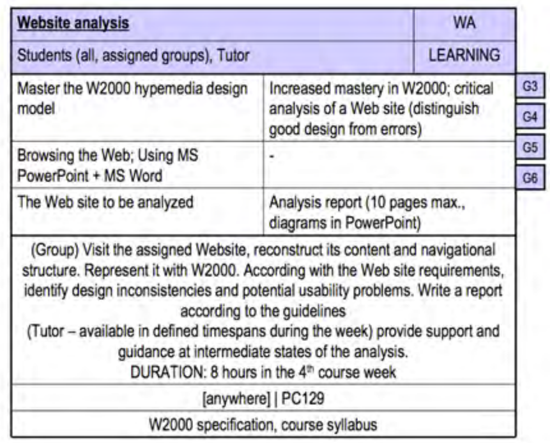


Figure 12. An example of an E^2ML activity flow diagram, (Botturi, 2003, p. 103)

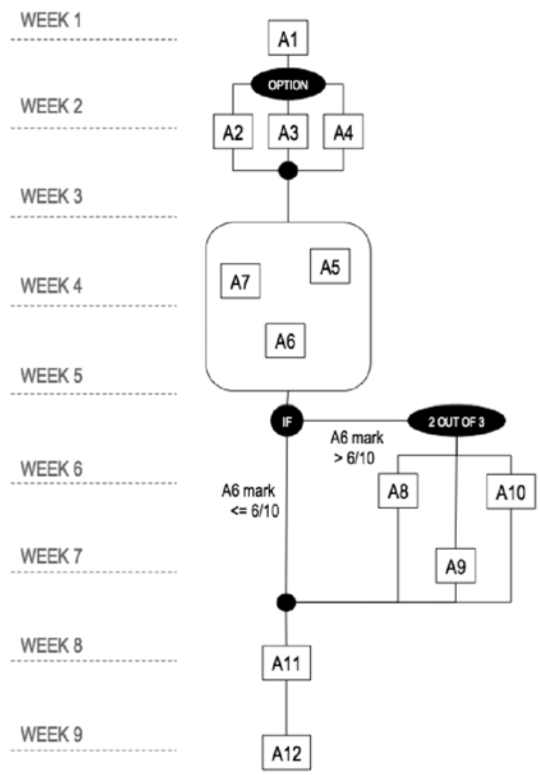
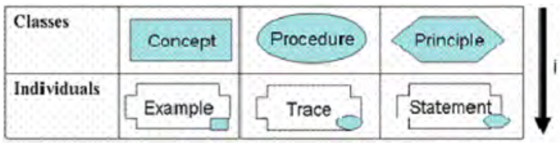


Figure 13. The integrated vocabulary of the MOT representation (Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006)

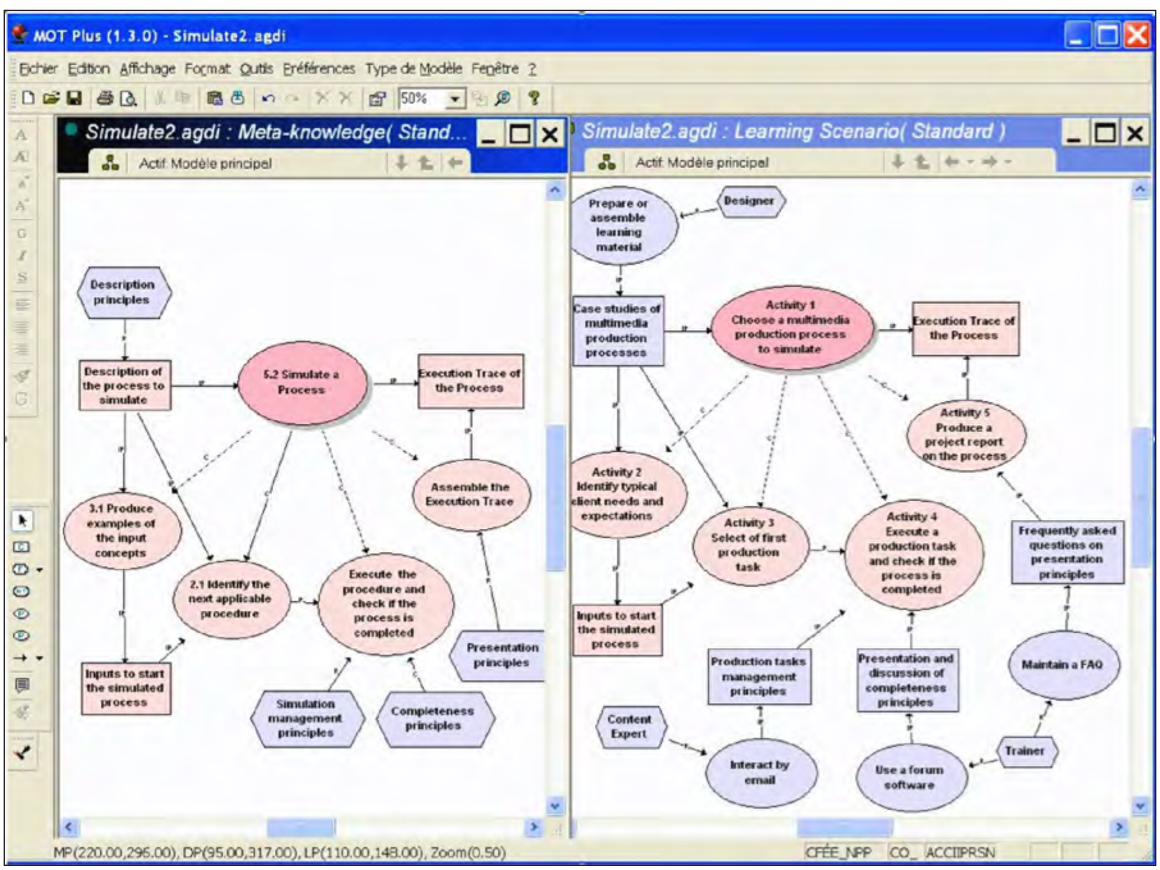


study discussed above. E²ML diagrams provide a level of detail that supports collaboration as well as detailing, documenting, and communicating a fully developed instructional design (as a language of design).

Paquette (1996; see also Chapter 8) created a graphic notation system, with supporting software, called MOT (an acronym for the French term Modélisation d'Ojets Typés). MOT includes symbols (See Figure 13) for abstract knowledge classes (concepts, procedures, and principles), as well corresponding individual facts (examples, traces, and statements). Similarly, lines (arrows) connecting the symbols also come in a number of types. MOT's abstract knowledge classes correspond to object-oriented programming *classes* and individual facts correspond to the *instantiations* of the classes.

Because MOT can be used for both abstract classes as well as specific instantiations, it is able to describe both models (types 4 or 5) and instances of instruction (type 1). Figure 14 shows an example of a generic cognitive skill model ("Simulate a process") on the left, and an activity structure based on this general skill ("Choose a multimedia production process") on the right. Figure 14 does

Figure 14. A MOT diagram showing both a meta-knowledge representation an a learning scenario (Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006)



not show a third level of specificity with specific instantiations of the classes in the general skill diagram, using the second set of symbols. The level of specificity it adds to the common hierarchical flowcharts of skills analyses, such as those found in Dick and Carey (1990), and in Gagné, Briggs, & Wager (1992) make it a good augmentation to these diagrams of content layer material.

Examples of MOT from Paquette's writing most often document Gibbons' content layer (for example, knowledge analyses), and strategy layer (for example, instructional activities). With MOT's primitives, this notation system can be applied to virtually any general notation task that uses containers and arrows, such as Laseau's (1986) bubble diagrams and networks. Because of its basic structure, MOT might be used to illustrate other layers of design if those layers can be illustrated abstractly.

MOT's basic approach also makes it flexible enough to serve the various stages of design. As noted, Paquette and his colleagues have created software for creating MOT diagrams, but virtually any diagramming software that allows custom symbols (such as Visio or Omnigraffle) would be capable of implementing MOT. In addition, MOT's symbol set and concept are simple enough that they could be the basis of hand-drawn design drawings.

SUMMARY OF DESIGN DRAWING IN ID

Our purpose in this chapter has been to understand the usage and breadth of design drawings in ID. These visual representations of instructional design are closely related to VIDLs. In other design fields, the use of graphics, sketches, or drawings in design is highly developed widely studied (see, for example, Robbins' (1998) book *Why Architects Draw*.)

We began with a review of ID literature to see if we could observe a similar tradition in ID. To conduct this review, we sampled several ID textbooks, ID journals, software, and case studies looking for examples of design drawing. We learned to distinguish design graphics from four other types of design drawings typically found in the literature (content graphics, reporting graphics, illustrations of ID models, and instructional and learning models). With design graphics identified, we categorized them using Gibbons' (2003) seven ID layers as a kind of taxonomy to understand the purposes for which these design drawings were created. These layers are: content, strategy, control, message representation, media-logic, and data management.

We did not find the same pervasiveness or level of self-awareness as found in other design fields. Examples of design drawings were found, but were somewhat rare. Furthermore, we discovered that those examples we found tended to document only two of Gibbons' seven layers: content and strategy (with some exceptions) indicating narrow application. We believe this gap represents a serious shortcoming in ID, indicating a lack of tradition, skill, and standards for visual representations of design except in limited ways.

It is widely held that a common visual language for conveying design ideas has facilitated progress in many other fields of design. The lack of such as medium in ID may be a roadblock to improving the practice of ID. This book represents a possible groundswell of interest in the subject of visual design languages for ID. At present, design drawing is a rare but growing phenomenon in ID, which, when fully understood and implemented, can only benefit the practice of ID.

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ENDNOTE

[1] This chapter was adapted from parts of Stubbs (2006, unpublished dissertation)

Handbook of Visual Languages for Instructional Design: Theories and Practices

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