What and how do designers design?

A Theory of Design Structure and Layers

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Editor's Note

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A question I always ask my Instructional Technology students at Utah State University is, "What do instructional designers design?" We have had interesting discussions on this question, and I try to revisit the question at several points throughout all of my classes. I find that the students' perceptions of what instructional designers design changes over time. This is no doubt a product of the faculty's teaching, but it also represents a personal commitment that the student makes. What the student commits to is what I would like to talk about. My thesis will be that it is a commitment to a particular layer of the evolving instructional design. I will talk about the layering of instructional designs and the implications for both teaching and practicing instructional design.

The Centrisms

Here are some of the phases I see students evolving through as they mature in their theoretic and practical knowledge:

Media-centrism. Media-centric designs place great emphasis on the constructs related to the instructional medium. The technology itself holds great attraction for new designers. They often construct their designs in the vocabulary of the medium rather than seeing the medium as a plastic and preferably invisible channel for learning interaction (See Norman, 1988; 1999). We are currently experiencing a wave of new media-centric designers due to the accessibility of powerful multimedia tools and large numbers of designers "assigned

into" computer-based and Web-based training design. Most of these designers speak in terms of the medium's constructs (the "page," the "hyperlink,", the "site," etc.) as the major design building blocks. Many struggle as they attempt to apply inadequate thought tools to complex design problems.

Message-centrism. Realizing that media design building blocks do not automatically lead to effective designs, most designers begin to concentrate on "telling the message better" in order to "get the idea across" or "make it stick." This is a phase I call message-centrism. Message-centric design places primary importance on message-related constructs—main idea, explanation, line of argument, dramatization, etc.— and employs media constructs secondarily, according to the demands of the message. The media constructs are used, but they are used to serve the needs of better messaging. Better message telling means different things to different designers: providing better illustrations, using animations, wording the message differently, using analogies, or focusing learner attention using attention-focusing questions, emphasis marks, repetition, or increased interactivity.

Strategy-centrism. Message-centrism is normally followed by a recognition of underlying structural similarities within messages and interactions that cross subject-matter boundaries and that have important instructional implications. This leads to a new viewpoint I call strategy-centric design thinking. Strategy-centrism considers the structured plan of messaging and interaction as a main source of instructional effectiveness. Therefore, the designer's first attention is to strategic constructs that are appropriate to instruction in categorized varieties of learning. Strategy-centric design can be viewed as the use of rules to governing the delivery of compartmentalized information and interaction elements (Gagne, 1985; Merrill, 1994). This can be a very useful conception for both the designer and the learner, and structured strategy is an important key to logic templating and design automation.

Model-centrism. Whereas strategy centrism permits the use of instructional experts (Zhang, Gibbons, & Merrill, 1997), it does not lead the designer to design interactive micro-worlds in which instruction can take place through problem solving. This realization leads to model-centered design thinking. Model centering encourages the designer to think first in terms of the system and model constructs that lie at the base of subject-matter knowledge. The designer therefore gives first consideration to identifying, capturing, and representing in interactive form the substance of these constructs. Then to this base of design is added strategy, message, and media constructs. Model-centrism is the common thread running through virtually all new-paradigm instructional approaches (for a review, see Gibbons & Fairweather, 2000). Many current researchers consider learning to be a problem-solving activity (Anderson, 1993; Brown & Palincsar, 1989; Schank, 1994; VanLehn, 1993). If this view is correct, then the designer must also give first preference to decisions about the problems the learner will be asked to solve. A model-centered view prescribes instructional augmentations that support problem solving in the form of coaching and feedback systems, representation systems, control systems, scope dynamics, and embedded didactics (see Gibbons, Fairweather, Anderson, & Merrill, 1997).

These phases in the maturation of design thinking tend to be encountered by new designers in the same order, and one could make the argument that these phases describe the history of research interests in the field of instructional technology as a whole. A good place to see this trend in cross-section is the articles in the *Annual Review of Psychology* beginning with the review by Lumsdaine and May (1965) and progressing through subsequent chapters by Anderson (1967); Gagne & Rohwer (1969); Glaser & Resnick (1972); McKeachie (1974); Wittrock & Lumsdaine (1977); Resnick (1981); Gagne & Dick (1983); Pintrich, Cross, Kozma & McKeachie (1986); Snow & Swanson (1992); Voss, Wiley & Carretero (1995); Sandoval (1995); VanLehn (1996); Carroll (1997); Palincsar (1998); and Medin, Lynch & Solomon (2000).

I am interested in this paper in exploring the roots of this progression. Important clues can be found in design areas outside of instructional design. A provocative statement on design structure is given by Brand (1994) in a description of how buildings are seen by architects and structural engineers. Brand begins by stating that architects see a building as a system of layers rather than as a unitary designed entity. He names six general layers, illustrated in Figure 1 and described below in his own words:

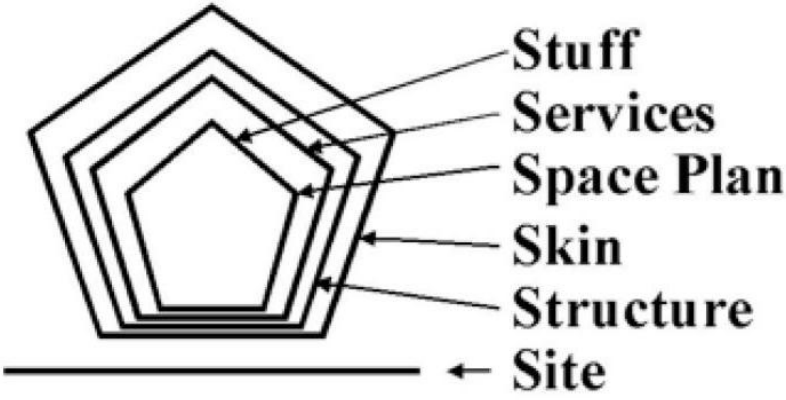

Figure 1. Layers of building design.

- SITE – This is the geographical setting, the urban location, and the legally defined lot, whose boundaries and context outlast generations of ephemeral buildings. “Site is eternal,” Duffy agrees.
- STRUCTURE – The foundation and load-bearing elements are perilous and expensive to change, so people don’t. These **are** the building. Structural life ranges from 30 to 300 years (but few buildings make it past 60, for other reasons).
- SKIN – Exterior surfaces now change every 20 years or so, to keep with fashion and technology, or for wholesale repair. Recent focus on energy costs has led to reengineered Skins that

are air-tight and better insulated.
- SERVICES – These are the working guts of a building: communications wiring, electrical wiring, plumbing, sprinkler system, HVAC (heating, ventilating, air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every 7 to 15 years. Many buildings are demolished early if their outdated systems are too deeply embedded to replace easily.
- SPACE PLAN – The interior layout—where walls, ceilings, floors, and doors go. Turbulent commercial space can change every 3 years or so; exceptionally quiet homes might wait 30 years.
- STUFF – Chairs, desks, phones, pictures, kitchen appliances, lamps, hair brushes; all the things that twitch around daily to monthly. Furniture is called **mobilia** in Italian for good reason. (p. 13)

Brand points out some important implications of the layered view of design:

1. That layers of a design age at different rates,
2. That layers must be replaced or modified on different time schedules,
3. That the layers must be articulated with each other somehow, and
4. That designs should provide for articulation in such a way that change to one layer entails minimum disruption to the others.

In work for the Center for Human-Systems Simulation, my colleagues Jon Nelson and Bob Richards and I have applied Brand's ideas to instructional design (Gibbons, Nelson & Richards, 2000). We have found that instructional designs can indeed be conceived of as multiple layers of decision making with respect to different sets of design constructs, and we find a rough correspondence between the layers and the phases of designer thinking already described.

Gibbons, Lawless, Anderson and Duffin (2001) show how layers of a design are compressed at a “convergence zone” with tool constructs that give them real existence and embody them in a product.

Tables 1 through 7 following this article, summarize what we think are the important layers of an instructional design: model/content, strategy, control, message, representation, media-logic, and management. Each layer is characterized in the tables by the following sets:

- A set of design goals unique to the layer,
- A set of design constructs unique to the layer,
- A set of theoretic principles for the selection and use of design constructs,
- A set of design and development tools, and
- A set of specialized design processes.

In addition, a layer often corresponds with a set of specialized design skills with its own lore, design heuristics, technical data, measurements, algorithms, and practical considerations. The boundaries of these skills over time tend to harden into lines of labor division, especially as technical sophistication of tools and techniques increases.

More detailed principles of design layering are outlined in Gibbons, Nelson, and Richards (2000). The purpose of the present paper is to show how design layering influences the designer’s thinking and allows it to change over time into entirely new ways of approaching the design task. The media, message, strategy, and model-centric phases designers experience can be explained as the necessary focus of the designer first and foremost on a particular layer of the design. That is, the designer enters the design at the layer most important to the design or with which the designer is most familiar and comfortable.

Media-centric designers do not ignore decisions related to other

layers, but because they may not yet be fully acquainted with the principles of design at other layers, they naturally think in terms of the structures they do know or can acquire most rapidly—media structures. As designers become aware of principles at other layers through experience and the evaluation of their own designs, focus can shift to the constructs of the different layers: message structurings, strategy structurings, and model and content structurings. Each step of the progression in turn gives the designer a new set of constructs and structuring principles to which to give the most attention, with other layers of the design being determined secondarily, but not ignored.

Is there a “right” layer priority in designs? Should designers always be counseled to enter the design task with a particular layer in mind? It is not possible to say, because design tasks most often come with constraints attached, and one of those constraints may predetermine a primary focus on a layer. An assignment to create a set of videotapes will lead the designer to pay first and last attention to the media-logic and representation layers, and other layers are forced to comply with the constraint within the limits of the designer’s ingenuity.

Conclusion

The design layering concept has many implications. In this paper I have explored one of them that explains the maturation in designer thinking over time. In order to move to a new perspective of design it is not necessary to leave older views behind. The new principles added as the designer becomes knowledgeable about each new layer adds to the designer’s range and to the sophistication of the designs that are possible. Further consideration of the layering concept will expand our ability to communicate designs in richer detail, achieve more sophisticated designs, and add to our understanding of the design process itself.

Table 1. Model/Content Layer Description

Layer Design Goals	Common Layer Design Constructs

	(Incomplete sample list)
To define the units of content segmentation	Model Relation Production rule Working Memory Element Proposition Fact Concept Rule Principle Task Task grouping Theme Topic Main idea Semantic relationship Chapter
To define the method of content capture	
To gather content elements	
To articulate content structures:	
With the Strategy layer	
With the Control layer	
With the Message layer	
With the Representation layer	
With the Logic layer	
With the Management layer	

Design Processes: Task Analysis, Cognitive Task Analysis, Rule Analysis, Content Analysis, Concept Mapping

Design/Production Tools: Data base software, Analysis software

Table 2. Strategy/Event Layer Description

Layer Design Goals	Common Layer Design Constructs
To define event structures (time structures) To define event hierarchies To define rules for event generation To articulate strategy structures: With the Content layer With the Control layer With the Message layer With the Representation layer With the Logic layer With the Management layer	(Incomplete sample list) Problem Information event Interaction event Exercise Instructional period Discovery challenge Unit Lesson Strategy component Argument Argument support

Design Processes: Strategy planning, Problem planning, Challenge formation, Activity planning, Exercise design

Design/Production Tools: Data base software

Table 3. Control Layer Description

Layer Design Goals	Common Layer Design Constructs

To define the set of possible user actions	
To define the rules of control availability To define the rules for control action To define the rules/processes for response recognition, parsing, and judging To articulate control structures: With the Content layer With the Strategy layer With the Message layer With the Representation layer With the Logic layer With the Management layer	(Incomplete sample list) Menu item Administrative control Strategy control Message control Representation control Logic control Content control Forward, Back Play, FF, FR, Stop, Pause Exit, Quit

Design Processes: Flow planning, Control walk-through, Diagramming

Design/Production Tools: Flowcharting, GUI-logic construction authoring systems

Table 4. Message Layer Description

Layer Design Goals	Common Layer Design Constructs

	(Incomplete sample list)
	Main idea
	Example
	Non-Example
	Discussion block
To define message types	Commentary
	Advance organizer
To define message composition by type	Primitive message element
	Spatial relationship
To define rules for message generation	Temporal relationship
	Causal relationship
To articulate message structures:	Hierarchical relationship
With the Content layer	Explanation
With the Strategy layer	Stem
With the Control layer	Distractor
With the Representation layer	Response request
With the Logic layer	Transition message
With the Management layer	Goal statement
	Directions
	“Resource”
	Database entry
	Coaching message
	Feedback message
	Hint

Design Processes: Message design, Strongly related to Strategy design

Design/Production Tools: Timeline-building tools, Flow diagrams

Table 5. Representation Layer Description

Layer Design Goals	Common Layer Design Constructs

To select media	
To define media channels	
To define channel synchronizations	
To define representation structures by type	(Incomplete sample list)
To select representation production tools	Background Resource file (audio, video)
To match production tool structures	Resource file (BMP, JPG, GIF, MPG)
To define rules display structure	Headline, Body
To define rules for display generation	Placeholder 3-D object
To define rules for structure generation	Rendering Animation
To define rules for display management	Tag parameter Sprite
To articulate representation structures:	Control icon Layer (e.g., Photoshop, Dreamweaver)
With the Content layer	
With the Strategy layer	
With the Control layer	
With the message layer	
With the Logic layer	
With the Management layer	

Design Processes: Display design, Formatting, Display event sequencing, Media channel synchronization, Media channel assignment

Design/Production Tools: All content/resource production tools for all media, All layout or formatting tools for all media, Display managers

Table 6. Logic Layer Description

Layer Design Goals	Common Layer Design Constructs
To define media-logic structures by type	(Incomplete sample list)
To define rules to apply logic structures	Display
To select logic construction tools	Branch
To define segmentation/packaging plan	Program
To define logic distribution plan (time)	Command
To articulate logic structures:	Procedure
With the Content layer	Program object
With the Strategy layer	Applet
With the Control layer	Application
With the Message layer	Book, object
With the Representation layer	Movie, stage, actor
With the Management layer	Object, Method, Data
	Site, Page
Design Processes: Program design, Program construction	
Design/Production Tools: All logic production tools, Modeling languages (e.g., UML)	

Table 7. Management Layer Description

Layer Design Goals	Common Layer Design Constructs

To define session control rules/procedures

To define the rules for initiative sharing
To define transition between events
To define record keeping and recording
To define variable-keeping and use
To define outside communications: Host, Peer, Net, Libraries, Databases
To define data reporting: Learner, Instructor, System
To plan security/privacy policy/provisions
To plan evaluation activities
To plan implementation activities
To plan management activities
To articulate management structures:
With the Content layer
With the Strategy layer
With the Control layer
With the Message layer
With the Representation layer
With the Logic layer

(Incomplete sample list)

Menu
Record
Variable
Database entry

Design Processes: Management planning, Implementation planning, Evaluation planning

Design/Production Tools: Data base software

Application Exercises

- Select one centrism and describe its strengths and weaknesses.
- Examine an online course that you have taken in the past. Identify the elements included in each design layer.

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Further Resources

For more information on Andrew Gibbons' theory of design layers, see the following resources:

- Gibbons, A. S. & Rogers, P. C. (2009). The architecture of instructional theory. In C. M. Reigeluth & A. Carr-Chellman (Eds.), *Instructional-design theories and models, Volume III: Building a common knowledge base*. New York: Routledge.
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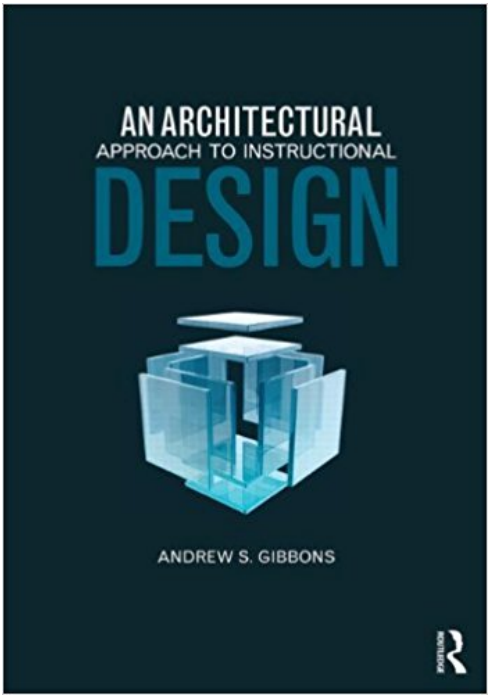

Please complete this short survey to provide feedback on this chapter: http://bit.ly/DesignLayers

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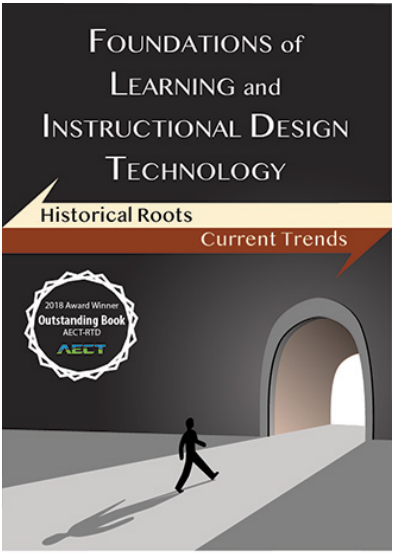

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