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EVALUATION PROCESSES IN AN "UNEXPERT" DESIGNER

by

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Abstract:

There are two kinds of evaluation in design. The first kind evaluates whether a proposal is acceptable or not. The second, when a proposal has been deemed unacceptable, evaluates choices about what to do next. This paper focusses on the second kind of evaluation. To do so, it identifies four major process types in design: proposing, evaluating (of the first type), programing requirements, and learning (or researching), and examines what conditions cause a change from one process to another. It then examines the kind of change that can occur within a single process area, in terms of scale, constraint, and ends-means, and what conditions cause a change within such an area. Finally, the paper discusses the interaction between these two kinds of changes.

This paper is one of a series intended to structure an approach to the development of an integrated design support system, a project of The Fine Tools Group of the College of Architecture and Urban Studies at Virginia Tech.

Introduction:

This paper is concerned indirectly with the development of an integrated computer support system for facility design, construction, and management -- and with its organization as an expert system. [1] The paper is concerned directly with design process and the changing activities and representations that are used in design. It is concerned especially with the events that trigger a change in activity.

If the theory in an area of activity is so exact that rigorous mathematical models can be produced, then that area does not need an expert system. Indeed, expert systems have come into use to support just those areas where theory is inexact and where the process is so complex that encompassing theory doesn't exist. But, curiously, development of an expert system forces the development of theory; a system requires a structure, and a structure requires a "working" descriptive and explanatory theory. Development of an expert system thus forces an examination of theory, and use of the system tests that theory.

Design is just such an area. Design is complex and the theory explaining design is inexact. While papers on design theory come in many varieties, [2] we will consider only that part of theory that is concerned with process and with judgments that modify process.

Our topics are: the major process areas in design, how movement occurs between the different process areas, the kinds of movement within a process area, and how movement occurs within such an area. We use the term, "movement," as a shorthand expression for "a change in the manner of representation of the design issues being pursued." As we identify the different process areas, we also describe the different working environments needed in our integrated support system and the kind of representations that each requires. As we examine the movement within a single process area, we also describe the changes of representation required in that area. [3]

As we begin this discussion, it will help to distinguish between two kinds of evaluation. The first kind is the evaluation of the acceptablility of a design proposal; you will notice below that one of the major process areas is concerned with evaluation of this kind. The second kind of evaluation is different in nature; it is the evaluation of what to do next when a proposal has been deemed unacceptable. Our paper focusses on this second kind of evaluation. We are concerned with the sequence of efforts during a design process and with what decisions determine that sequence.

The Major Process Areas in Design:

In the well-known 1951 volume, TOWARD A GENERAL THEORY OF ACTION, Talcott Parsons and his co-authors proposed a classification of actions across three polar pairs: learning-performing, internal-external, and integrative-allocative. [4] In short, learning can be taken as changing ones ability to perform, in contrast with performing; internal and external refer to the locus of the problem that the action addresses; finally, integrative and allocative refer to different conceptual styles in action. In the following, we use the categories proposed by Parsons, but we do not follow his exposition, since our subject of concern is very different.

A full expansion of these three pairs produces eight modes of action. For our purposes in dealing with design, however, these can be reduced substantially. As we describe the different modes, it will help to follow the diagram in Figure 1.

A Proposing Mode: The development of a design proposal falls into the triple classification: performing, external, and integrative. It is performing since it develops a proposal; it is external since it is concerned with modifications to the external world (instead of the internal mindset), and it is integrative since it attempts to achieve a resolution of multiple elements.

An Evaluating Mode: The evaluating of a proposal changes from an integrative conceptual style to an allocative conceptual style. The action is still performing, and the locus is still external.

A Programing Mode: This is a mode that is internal since it is concerned with the needs of the users. It remains performing, but can shift between allocative and integrative.

A Learning Mode: This mode shifts away from performing to permit the designer to acquire information and skills needed for design. It is primarily external, but is concerned with both integrative and allocative information. This is the only mode that is not a performing mode.

If we introduce a distinction between situational and typological knowledge where typological knowledge is knowledge about the kind of building or object being designed, and situational knowledge is about the particular project under consideration, we might improve the understanding of the different modes. [5] The Programing Mode gives access to situational knowledge, the Learning Mode (and its library) gives access to typological knowledge, and the Evaluating Mode lets us test, against those kinds of knowledge, the building configurations developed in the Proposing Mode.

Changes from One Process to Another:

In the section above we described the major process areas needed in an integrated support system. Let us turn now and describe them as support environments.

A Proposing Environment: An environment for visualizing, describing, and displaying design proposals. It provides notations for area diagrams, bubble diagrams, preliminary sketches, pattern notations, and full representation of three dimensional objects. [6]

An Evaluating Environment: An environment to test the configuration of objects for their structural and mechanical properties and for their size and their functional relationship. An environment to test the proposed components for performance according to both specific and typological requirements.

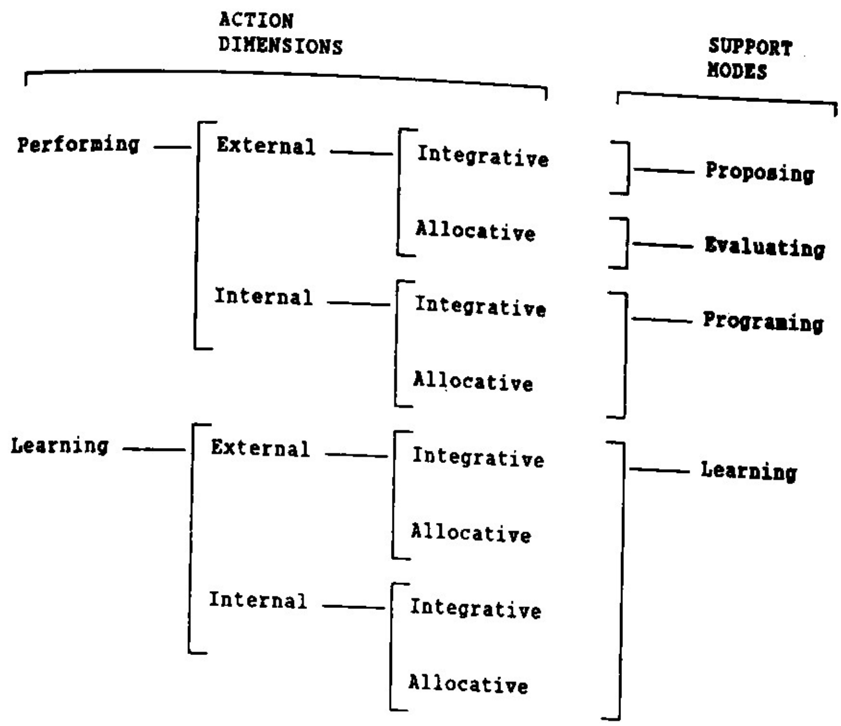
A Programing Environment: An environment that lets a designer develop a dynamic model of the institution which is the design client, and thus models the changing requirements that the institution has for the project. An environment that lets the designer deal with the specific requirements for the project.

A Learning Environment: An environment to access public databases for information on legal requirements and physical data. An environment to provide typological requirements for use in the project. [7] An environment to access components of past projects for adaptation to a current project, thus -- An environment that provides instances of solutions for the particular types to which the project and its components belong. [8]

Since each of these different environments corresponds to an activity during a "manual" design process, we have fairly good knowledge about the conditions that invoke a change from one activity to another.

From: Proposing To: Evaluating		Need to confirm that a physical design component satisfies some particular criteria or constraint. Such constraints are generated in the Programming or Learning environments.
From: Proposing To: Programming		Need to review requirements in order to compare functionality of proposed object with required functionality.
From: Proposing To: Learning		Need to review ways in which past projects have provided similar functionality. Need to review code constraints. Need to review physical conditions.

Figure 1.



Different Dimensions Within a Design Process:

In speaking of different dimensions in a modeling environment, we speak of changing the representation of a project. We can be selective in what parts of a project we want to examine. Consider three separate dimensions:

An Ends-Means Dimension: A dimension that extends across a series of representations from the relatively abstract and verbal to the relatively concrete and pictorial. It includes ways of representing persons (& institutions), purposes, behaviors, functions, and objects (& buildings). This dimension can also be thought of as a demand-supply dimension or a general-specific dimension. [9]

A Whole-Part Dimension: A dimension that ranges from the broadest, most inclusive, view of a project to the narrowest and most detailed view of some part of a project. Movement across this dimension is in conventional jumps from site, to building group, to building plan, to room plan, to construction detail. [10]

A Constraint Dimension: A dimension that ranges from an examination of all systems together to the examination of a single system in isolation. This dimension can also be thought of as a systems dimension. [11]

Movement Along the Different Dimensions:

Since these different dimensions exist, what is it that causes movement along one or the other dimension? Let us consider each dimension in turn. As we do so, please remember that "movement," is a shorthand expression for "a change in the manner of representation of the design issues being pursued."

The Ends-Means Dimensions: The purpose of the design process is to produce an object description that will respond to a purpose and need description. This is simply to say that the overall movement across the ends-means dimension is from ends to means, or stated in another way, from the person-descriptive to the object-descriptive end of this dimension. Such movement passes through a number of representations: verbal program descriptions, adjacency matrices and bubble-diagram representations of program connections, schematic design drawings, sketches, design development drawings, and full spatial representations of a building proposal. This movement, however, is not continuous and linear, but circular and iterative. [12] Movement toward the object end occurs when the designer is ready to develop a next stage of detail and a fuller realization of a design proposal. Movement toward the person end occurs to check the state of prior representations, and to consider the modification of prior representations.

The Whole-Part Dimension: Movement along the whole-part dimension occurs to consider a lower-level part or to consider a higher-level context. In general, movement to a lower level seeks a fully known condition or kind of component. [13] (To determine the size of a motel layout, one must know how many rooms and the size of a room. To determine the size of a room, one must know the disposition of furniture and walking paths and their sizes.) In general movement to a higher level is for the purpose of fitting a thing into that higher level context. Both processes are recursive and continue until a known or knowable condition is reached.

The Constraint Dimension: Movement to reduce constraint moves to consider fewer "systems" of the project. It moves to reduce the number of confounding variables in order to achieve a fully known condition. It can move to consider a single system of the project (e.g., the structural system), or to consider as few systems as possible to deal with the current issue. Movement to increase constraint helps determine whether the resolution of single system can guide the organization of all systems together. In dealing with these issues the designer considers two kinds of constraint, internal constraint within a single system, and external constraint between interacting systems. High internal constraint in a system generally forces a lower external constraint between systems. Lower internal constraint within a system permits higher external constraint between systems. [14]

Conclusion:

We have described two major structures within an integrated support system. In doing so we have also described how building designers work. To give a complete description of design process, we also need to describe the interaction of these two structures.

Within an integrated support system, the designer works in one of the process areas. Within that process area the work is located at a particular "dimensional" location, somewhere along the ends-means dimension using a notation appropriate to that placement, somewhere along the whole-part dimension with a scale appropriate to that placement, and somewhere along the constraint dimension with a display appropriate to the systems under consideration. As the designer moves to a different process area, the dimensional location within the former process area is preserved, and appropriate tools in the new process area are brought up for use according to that dimensional location.

If work in the original process area was concerned with full detail development of a building representation, at the building plan scale with a focus on the structural system moves to other process areas would bring up material pertinent to that placement. A move to Programming would let the designer review any special structural requirements that the client had requested. A move to Learning would permit the designer to review structural code requirements, available structural members, and configurations used in earlier projects to handle similar situations. A move to Evaluating would assist the designer in testing a proposed structural member against those requirements.

As the designer moves from one process area to another the internal work location within a process area is preserved. As the designer moves internally to change his or her work location the process area is preserved.

This paper has skimmed over the surface of this work. Two issues that will occupy much of our attention as we proceed have to do with notation schemes and with evaluation procedures. We state them here in order to return to them in depth at a later time:

> The need for a notation to express complex ideas suggests that every complex idea depends on a structuring of simpler ideas well enough established to have been imbedded in the notation scheme.

> Design does not follow the generate-and-test problem solution procedure; instead, it generates a candidate solution, then searches for possible test criteria which will give approval to the candidate. [15]

Notes:

(Working papers mentioned herein are available by addressing their author at The College of Architecture and Urban Studies, Virginia Tech, Blacksburg, VA 24060, USA)

[1] A working paper and prospectus describing the proposed design support system is:

Wade, John W., THE FINE TOOL SYSTEM FOR ARCHITECTURAL AND ENGINEERING PRACTICE

[2] The Journal, DESIGN METHODS AND THEORIES, contains articles on a variety of these subjects. In its Twentieth anniversary issue (20-2) in 1986 it published a list of nine books that have defined the field of design method and theory. The following books were among that list and can provide a useful review of the range of topics in design theory:

Gregory, Sydney, (ed.) THE DESIGN METHOD, Plenum, New York, 1966.

Broadbent, Geoffrey, DESIGN METHODS IN ARCHITECTURE, Lund-Humphries, London, 1969.

Moore, Gary, EMERGING METHODS OF ENVIRONMENTAL DESIGN AND PLANNING, MIT Press, Cambridge, 1970.

Jones, J. Christopher, DESIGN METHODS: SEEDS OF HUMAN FUTURES, Wiley, New York, 1970.

Wade, John W., ARCHITECTURE, PROBLEMS, AND PURPOSES, Wiley, New York, 1977.

Heath, Tom, METHOD IN ARCHITECTURE, Wiley, New York, 1984.

[3] An interesting discussion of the importance of notation systems as aids to detailed creative thought occurs in:

Bochenski, J. M., THE METHODS OF CONTEMPORARY THOUGHT, Harper & Row, New York, 1968, p.32ff.

[4] Parsons, Talcott, & Edward A. Shils (eds.) TOWARD A GENERAL THEORY OF ACTION, Harper & Row, New York, 1951.

[5] There is a strong treatment of the difference between typological information and situational information in

Schon, Donald A., "Designing: Rules, types and worlds," DESIGN STUDIES, Vol. 9, No. 3, July 1988.

[6] A working paper that describes the organization of spatial modeler that works directly with predefined spatial components in a shaded isometric view:

Wade, John W., DRAWADE III,

[7] There are many approaches to the organization of information for design. We have room to mention only a few of those approaches:

Burnette, Charles H., "The Design of Comprehensive Information Systems for Design," in Archea, John, and Charles Eastman (eds.), EDRA Two, Proceedings of 2nd Environmental Design Research Association Conference in 1970.

Turner, James A. "A Systems Approach to the Conceptual

Modeling of Buildings," a working paper presented at Lund meeting in 1988 of W74 & W78 working groups of CIB.

Committee on Integrated Data Base Development, THE 1986 WORKSHOP ON INTEGRATED DATA BASE DEVELOPMENT FOR THE BUILDING INDUSTRY, Building Research Board, National Research Council, National Academy Press, Washington, 1987.

Jones, Dennis, INTERACTIVE MEDICAL FACILITIES PLANNING SYSTEM FOR VETERANS ADMINISTRATION OFFICE OF CONSTRUCTION: A three-dimensional spread sheet facility, VA contract #V101(93)P-1128 July 24, 1986.

We should also mention the CSI, SfB, and CI/SfB systems for classifying construction information, as well as the work by Colin Davidson with INDUSTRIALIZATION FORUM.

[8] A working paper describing a component based library for the Fine Tools Project.

Wade, John W., and Bettina DeDios, "Typification and Evaluation in Design,"

[9] There is a thorough treatment of the ends-means (or person-object) spectrum in:

Wade, John W., ARCHITECTURE, PROBLEMS, AND PURPOSES, Wiley, New York, 1977.

[10] It is interesting to examine whole-part relationships in terms of the literature that has grown up following Alexander's work:

Alexander, Christopher, NOTES ON THE SYNTHESIS OF FORM, Harvard University Press, Cambridge, 1964.

[11] Reducing constraint is described in some detail as a "planning heuristic" in:

Newell, Allen, and Herbert A. Simon, HUMAN PROBLEM SOLVING, Prentice-Hall, Englewood Cliffs, 1972.

[12] The iterative nature of design is explored carefully in:

Archer, L. Bruce, THE STRUCTURE OF DESIGN PROCESSES, U.S. Department of Commerce, National Bureau of Standards, 1968.

[13] The process is described as a "purchase" heuristic and as the opposite of "build-up" in:

Wade, John W., ARCHITECTURE, PROBLEMS, AND PURPOSES, Wiley, New York, 1977, p.323ff.

[14] Internal and external constraint are discussed in:

Garner, Wendell R., UNCERTAINTY AND STRUCTURE AS PSYCHOLOGICAL CONCEPTS, Wiley, New York, 1962.

[15] There would appear to be an interesting relationship between this idea and the notion of design as a puzzle-making/puzzle-solving process as described in:

Archea, John, "Puzzle-Making: What Architects Do When No One is Looking," in Kalay, Yehuda E., (ed.) COMPUTABILITY OF DESIGN, Wiley, New York, 1987.