The System Diagrams: Shifting Perspectives

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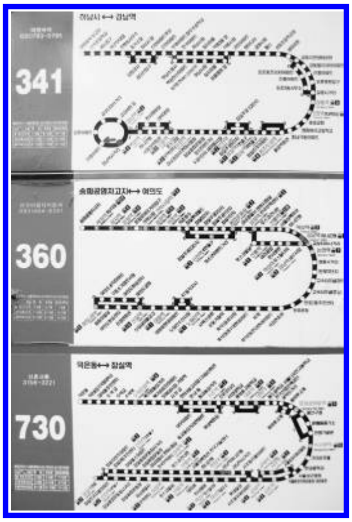
As society becomes increasingly saturated with information, the design of that information becomes ever more important. However, rather than reinforcing the agency of the user, many information design products limit one's possibilities for action. Take bus route maps (Figure 1), for instance. No problems emerge when looking at each bus route separately, but when users try to compare them to one another, it is difficult to understand their relationship. Only scattered information is made available, so that users are unable to form a clear, holistic understanding of how the bus service operates. Consequently, if an unexpected delay in a bus service were to occur, passengers might not be able to find and take an alternate route.

Although a variety of approaches are available to resolve this problem, using system diagrams is a method that allows information designers to consider the holistic context. It is necessary not only to understand the system itself but also to study diagrams as a means of effectively describing the system, which is abstract in nature. The use of diagrams is a key component in communicating the holistic structure of an information system; however, a lack of rigorous discussion in the field means that designers often have difficulty examining systems as an integral part of their work.

The purpose of this article is to provide a theoretical framework that broadens designers' conception of system diagrams and enables them to design diagrams that can be effectively applied to various situations, needs, and design problems. In the first half of the article, we introduce four kinds of system diagrams and analyze different examples; the second half of the article focuses on how different modes of thinking are used to address varied needs and goals in the design process.

Figure 1
Seoul bus map. Photograph taken by the author



Organizing Principles of System Diagrams

The term "system" can be traced back to the Greek word *sustēma*, which means reunion, conjunction, or assembly.[1] Philosophical interest in systems and system thinking has been around since the works of Plato and Descartes[2]; however, it gained momentum as a discrete subject of study around the 1950s, emerging alongside the rise of general system theory and cybernetics.[3] In his seminal article written in 1950, Ludwig von Bertalanffy asserts:

> As opposed to the analytical, summative, and machine theoretical viewpoints, organismic conceptions have

1 Charles François, "Systemics and Cybernetics in a Historical Perspective," *Systems Research and Behavioral Science* 16 (1999): 203.

2 Ibid, 203.

3 For a critical discussion of the historical development of system thinking, see Ludwig von Bertalanffy, "The History and Status of General Systems Theory," The Academy of Management Journal 15:4 (1972): 407–26, and Charles François, "Systemics and Cybernetics in a Historical Perspective," *Systems Research and Behavioral Science* 16 (1999): 203–19.

evolved in all branches of modern biology which assert the necessity of investigating not only *parts* but also *relations* of organization resulting from a dynamic interaction and manifesting themselves by the difference in behavior of parts in isolation and in the whole organism.[4]

He further defines the term system as "a set of elements standing in interrelation among themselves and with the environment."[5] In other words, the whole is more than the sum of its parts, and this characteristic of a system is derived from the relationship of its parts. While this definition of a system—which is based on the whole, the part, and the relationship—persisted for decades, the focus has recently shifted from object to human. Systems thinking has come to play a critical role in the fields of management, social science, and organizational design. According to Richard Buchanan, the emphasis is no longer on material systems, but on the human who experiences the system. Buchanan goes on to explain that:

> One of the most significant developments of system thinking is the recognition that human beings can never see or experience a system, yet we know that our lives are strongly influenced by systems and environments of our own making and by those that nature provides. By definition, a system is the totality of all that is contained, has been contained, and may yet be contained within it. We can never see or experience this totality. We can only experience our personal pathway through a system.[6]

The fundamental question, then, is this: how is it possible to design a system diagram if a system functions as a totality and humans are unable to experience the whole? In fact, the role of a system diagram is not a mere representation of a particular phenomenon or fact. According to Charles S. Peirce, a "diagram not only represents the related correlates, but also, and much more definitely, represents the relations between them, as so many objects of the Icon."[7] In other words, system diagrams are about relationships.

The word "relationship" should not be understood in reductive terms as merely a connection between numerous components; rather, it should be perceived as an idea or thought that integrates different parts into a whole—that is, the organizing principle of the system. Because humans cannot experience the totality of the system, Buchanan argues, "we create symbols or representations that attempt to express the idea or thought that is the organizing principle."[8]

Ultimately, this process is done in an effort to grasp the system. For example, a cross symbolizes the organizing principle of Christianity, whereas a road sign represents the driver's possibilities of action that shape the traffic system.

4 Ludwig von Bertalanffy, "An Outline of General System Theory," *The British Journal for the Philosophy of Science* 1:2 (1950): 134. Reprinted In *General System Theory: Foundations, Development, Applications* (New York: George Braziller, 1968).

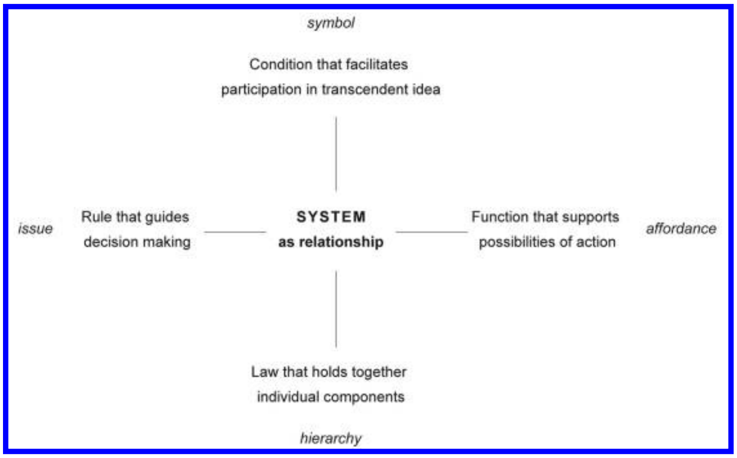
5 Ludwig von Bertalanffy, "The History and Status of General Systems Theory," *The Academy of Management Journal* 15:4 (1972): 417.

6 Richard Buchanan, "Design Research and the New Learning," *Design Issues* 17:4 (2001): 12.

7 Charles S. Peirce, "Prolegomena for an Apology to Pragmatism," in *The New Elements of Mathematics*, Carolyn Eisele, ed. (The Hague: Mouton Publishers, 1976), 4:316. (Original work was published in 1906.)

8 Richard Buchanan, "Design Research and the New Learning," 12.

Figure 2
Organizing principles of system diagrams



As the focus in considering systems has shifted to human beings, a system diagram should be regarded as a visualization of the organizing principle of the system; thus, the diagram is altered to become a *place* that opens up a user's possibilities of action and enables effective use of the system. In turn, the key to system diagrams is not simply to *represent* a relationship among things—it is to *understand* the relationship of how the system is organized, according to the intent of the designer, the purpose of user-action, and the collective function. To further investigate this notion of a system diagram, four kinds of diagrams are proposed. In these diagram types, relationships emerge depending on the following organizing principles[9] (Figure 2): 1) the law that holds together individual components, 2) the rule that guides decision-making, 3) the function that supports users' possibilities of action, and 4) the condition that facilitates participation in the transcendent idea.[10]

The System as a Law That Holds Together Individual Components

According to Herbert Simon, a system can be understood as an aggregation of individual components. In his book, *The Science of the Artificial*, Simon defines a complex system as "one made up of a large number of parts that have many interactions."[11] His intent was to figure out the fundamental quality of the interaction that constitutes the architecture of complex systems, ranging from artificial/natural adaptive systems and social systems to symbolic systems. Simon ultimately argues that the complex system is composed of subsystems, and the subsystems are again made up of their own subsystems. He recognizes this hierarchy to be the distinctive relationship among the parts that organizes them into a system. As Simon puts it, "hierarchic systems have some common properties independent of their specific content. Hierarchy is one of the central schemes that the architect of complexity uses."[12]

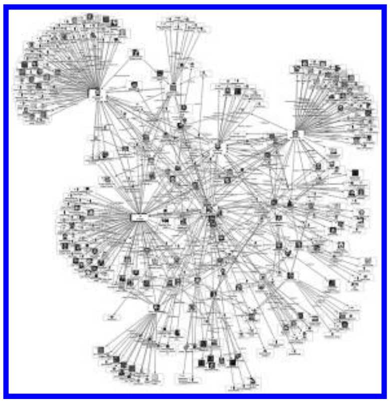
In other words, hierarchy can be explained as a kind of law that serves as an objective force and that is universally applicable.

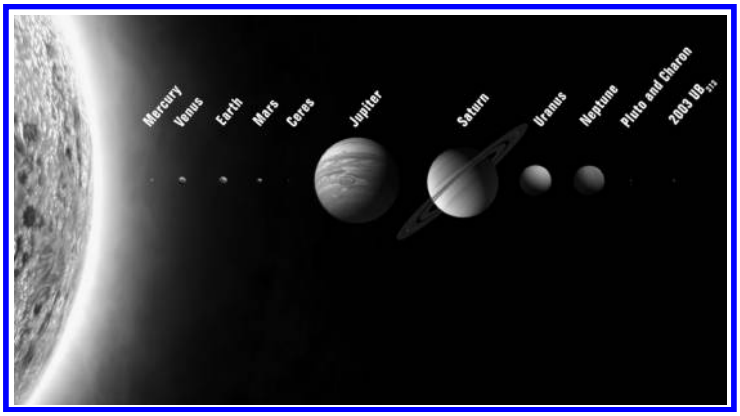
9 Distinctions made by these terms (i.e., law, rule, function, and condition) are based on the class discussion on kinds of systems (Richard Buchanan, *Design, Management, and Organizational Change*, class lecture presented at Carnegie Mellon School of Design, Pittsburgh, PA, Spring 2008).

10 For a more complete discussion of this term, see Richard Buchanan, "Children of the Moving Present: The Ecology of Culture and the Search for Causes in Design," *Design Issues*, 17:1, Winter 2001, 67–84. This term is more fully explained later in the article. Here, this notion of the "transcendent idea" is used to help further explore the nature of system diagrams.

11 Herbert A. Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, 1969), 183.

12 Ibid, 184.





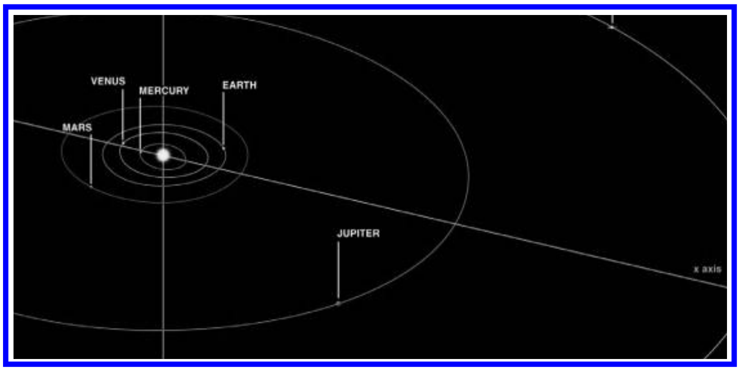


Figure 3 (above left)
Social network diagram. The FMS Advanced Systems Group. www.fmsasg.com/SocialNetworkAnalysis/SocialNetworkAnalysis_Graph.gif

Figure 4 (above right)
Solar system diagram. The International Astronomical Union. Design by Martin Kornmesser ©The International Astronomical Union

Figure 5 (right)
Solar system diagram. NASA, courtesy of nasaimages.org © NASA

A network diagram is one of the representative system diagrams that draws from this principle of hierarchical relationships among individual elements. Figure 3 is an example of social network analysis: similar to a molecule made of electrons, the individual people in the network diagram would be scattered data, without the hierarchical relationship visualized by the lines, the distances between people, and their overall positions. The repeated hierarchy of who gives orders to whom and who belongs to whose command becomes the core organizing principle that holds these individuals together into a system.

The two system diagrams (Figures 4 and 5) display the same celestial bodies from the solar system. However, the hierarchical law that serves as the organizing principle differs in these two diagrams, thus yielding two very different illustrations. Figure 4 focuses on the hierarchy of size rather than an exact representation of distance between the planets. In contrast, Figure 5 is clearly based on the hierarchy of distance, disregarding the hierarchy of size.

The System as a Rule That Guides Decision Making

The next approach is based on the understanding of a system as a set of rules that guides an agent's decision-making. In contrast to the first approach, which focuses on a hierarchy among individual components, the emphasis here is on the role of the agent in the system and, in particular, on choices that individual agents can make.

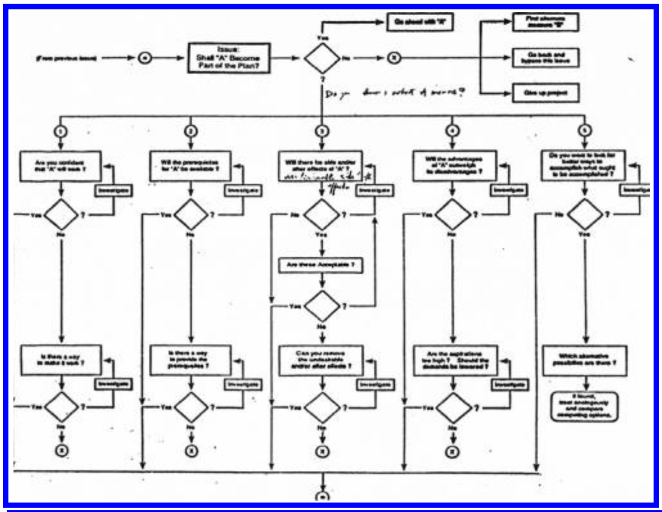


Figure 6
Flow chart, Horst W. J. Rittel, "The Reasoning of Designers," Arbeitspapier A-88-4. Stuttgart: Institut für Grundlagen der Planung, Universität Stuttgart, 1988.

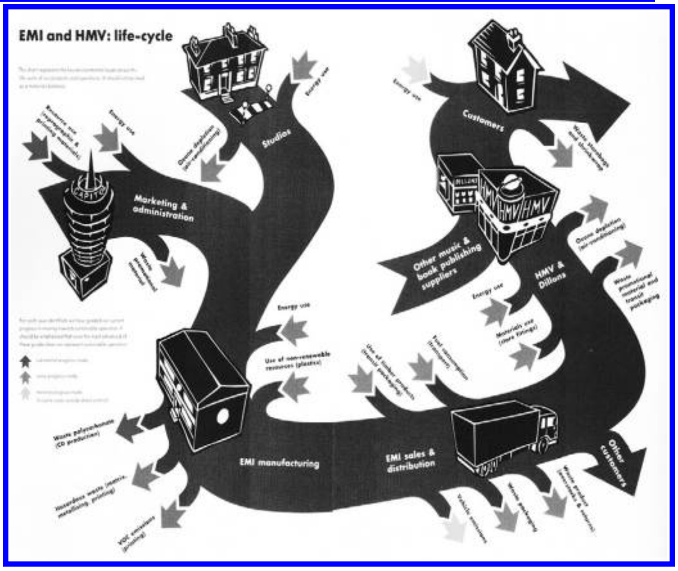


Figure 7
Music product life-cycle diagram. Designed by Tor Pettersen et al. in The Best Informational Diagrams (Japan: P.I.E Books), 48. ©Tor Pettersen & Partners

This approach is closely related to the discussion of information systems by Kunz and Rittel, who define a system as "constructs of rules and procedures which are meant to serve the desired end."[13]

It is important to stress that Kunz and Rittel applied rules and procedures to their discussion of systems. Instead of regarding a system as a piece of hardware that consists of individual components, they are interested in its human aspect—in the agency that operates the system. In this respect, rules that are arbitrarily chosen and changeable, rather than universal laws or truth, organize the second kind of system.

In addition to this concept of agency, it is also important to consider a system as an argumentative process that is based on "a model of problem-solving by cooperatives."[14] This "system as process" is articulated in Kunz and Rittel's discussion of an issue-based information system, where "issues" are identified as elements of the system, as are topics, positions, and arguments.[15]

13 Werner Kunz and Horst W. J. Rittel, "How to Know What Is Known: Designing Crutches for Communication" in *Representation and Exchange of Knowledge as a Basis of Information Processes,* H. J. Dietschmann, eds. (North-Holland: Elsevier, 1984), 57. (Original work was published 1983.)
14 Werner Kunz and Horst W. J. Rittel, *Issues as Elements of Information Systems*, Working Paper no. 131 (Institute of Urban and Regional Development, University of California, Berkeley, 1970), 1.
15 For a more detailed account of the issue-based information system, see Werner Kunz and Horst W. J. Rittel, *Issues as Elements of Information Systems*, 1–9.

Figure 8
Cologne-Bonn airport sign system. Designed by Toan Vu-Hu. www.toanvuhuu.com/projects/cologne-bonn-airport/ (accessed June 29, 2010) ©Toan Vu-Hu.

According to the authors, issues are "brought up and disputed because different positions are assumed."[16] This kind of system leads individuals to continuously make decisions about the issues that are created by their reasoning process, so they reach the decision considered most reasonable among all the other possibilities.

One common example that reflects this relationship of rules is a flow chart (Figure 6)—a diagrammatic representation of step-by-step procedures. By following a path through the flow chart, the individual expects to find a solution to a problem. Flowcharts have been used as a method for problem-solving because they translate whole process into manageable steps, where issues become focal points that determine the sequence of individual decision-making moments. Figure 7 is an example of a system diagram that visualizes the lifecycle of EMI Music products and operations. What makes this diagram distinct from other diagrams is its incorporation of related environmental issues; for instance, color-coded arrows organize key environmental areas, including manufacturing facilities and music-publishing suppliers.

The System as a Function That Supports Possibilities of Action

The third perspective focuses on understanding a system as a functioning group. This view emphasizes the notion of an organic whole, where the whole is lost if it is mechanically cut into parts. James J. Gibson proposes that human visual perception is not merely a channel but a system that requires all the parts to work together, with the explanation that "vision is a whole perceptual system, not a channel of sense. One sees the environment not with the eyes but with the eyes-in-the-head-on-the-body-resting-on-the-ground."[17] He further explains that a system has "organs" and is not just a sense with mere receptors. Thus, as Gibson states, "the perceptual capacities of the organism do not lie in discrete anatomical parts of the body but lie in systems with nested functions."[18] The function, then, is the key relationship that makes an organ a necessary part of the whole.

The concepts of *system* and *relationship* in this third approach are especially meaningful within the context of experience design. An experience is one's interaction with an environment, where the environment can be interpreted as a kind of system that supports one's possibilities of action. However, not just any kind of surrounding can serve as an environment for an organism. According to Gibson, the environment and the organism, or animal, are inseparable because the animal modifies the environment and the environment shapes the action of the animal. Therefore, the environment *affords* the animal, which means that the environment, as the system, provides the function of good or bad. Based on this functional relationship, Gibson constructs his theory of *affordance*, which is defined as a relationship between a living animal and its environment and their ever-changing interaction.[19] A system diagram

16 Ibid, 2.
17 James. J. Gibson, *The Ecological Approach to Visual Perception* (Boston, MA: Houghton Mifflin, 1979), 205.
18 Ibid. 205.
19 Ibid. 127.

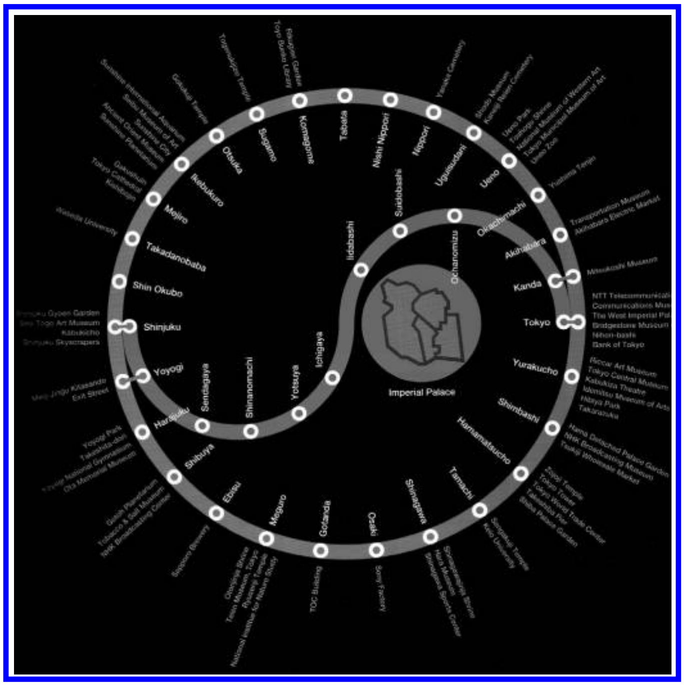


Figure 9
Tokyo subway map. http://japan-guide.com/ (accessed June 29, 2010) ©http://japan-guide.com/

Figure 10
Wurman's Tokyo subway map. Richard Saul Wurman, Tokyo Access. (Los Angeles, CA: Access Press, 1984). CRichard Saul Wurman

that exemplifies this approach is an airport sign system (Figure 8). Recognizing individual signs as affordances is difficult *until* the situation demands that the user understand the function of each sign and how the signs work together in a holistic relationship. This understanding is ultimately required to achieve one's goal when using this sign system. When action takers discover the relationships between the signs in the system, by the sheer act of navigating within the system they realize how the signs and maps in the environment function together. In this moment, arbitrary signs are related to other signs, and the surroundings subsequently morph into an environment that provides systematic support for possibilities of action.

The System as a Condition That Facilitates Participation in the Transcendent Idea

The fourth principle comes from the transcendent idea that harmonizes individual parts of a system. This transcendent idea can be spiritual, ethical, aesthetic, or cultural, depending on the context and purpose of the system. It serves as a vision that motivates humans to participate because "an ideal of beauty, truth, or justice" offers them meaning and values.[20] This relationship of a transcendent idea emphasizes the whole rather than the parts and is often communicated by symbols or emblems. Kenji Ekuan's discussion of the Makunochi Bento, or traditional Japanese lunchbox, can be helpful in articulating this notion of the transcendent idea.[21] For Ekuan, the Japanese lunchbox is a system that embraces diversity and yet assimilates all the different parts into a unified whole. He

20 Richard Buchanan, "Children of the Moving Present: The Ecology of Culture and the Search for Causes in Design," *Design Issues*, 17:1, Winter 2001, 82.

21 Kenji Ekuan, *The Aesthetics of the Japanese Lunchbox* (Cambridge, MA: MIT Press, 1998).

explains in detail how the contents of the lunchbox differ from one another, yet the form, the manner of preparation and delivery, and the ritual bring them all into harmony. From this perspective, the Makunochi Bento arguably embodies an aspect of Japanese culture, where diverse subcultures are unified by the transcendent idea. Indeed, the lunchbox itself symbolizes the spirit of Japanese culture.

A Tokyo subway map (Figure 10) designed by Richard Saul Wurman for the Tokyo Access Guide illustrates how a system diagram can convey this transcendent idea. In this map, the symbolic aspect is immediately recognized; meanwhile, an emphasis is placed on the Imperial Palace, which is marked as a red circle. The use of a symbol is effective not just because it simplifies the subway lines (Figure 9) into an easily recognizable sign; neither does it stand as a mere shape that makes the Tokyo subway map (Figure 10) distinct from the subway maps of other countries. More importantly, the form itself strives to capture the essence of Japanese culture and to challenge its users to ask themselves what might constitute Japanese culture as a whole. Thus, this system diagram not only signifies a subway route but also embodies Tokyo itself as a system. Ultimately, ordinary objects like subway maps and lunchboxes transcend their common status by potentially offering a new perspective—one that brings together different aspects of Japan into a unified whole.

Case Study: The USPS Domestic Mail Manual Transformation Project

Thus far, this paper has investigated different kinds of relationships that are found in various kinds of system diagrams. If understanding the relationship of individual components is the key to identifying the organizing principle of a system, would it be possible, then, to identify these relationships in the context of a design process? What is the primary focus of each relationship in the activity of designing? System diagrams can be used in various stages of the design process to serve the designer's purposes. For example, system diagrams can work as roadmaps at the very beginning of the design process, they can function as a means of communication with internal stakeholders, or they can be used by clients to make any necessary revisions they deem important. They can also become a final product for customers to find information and to educate themselves. System diagrams in different phases of the design process have distinct characteristics; meanwhile, they can also be distinguished by their purpose and context of use. Consequently, these distinctions can change both the relationship within a diagram and its formal representation.

This paper now examines how different kinds of relationships emerge in various system diagrams created in a specific design research project. The Domestic Mail Manual (DMM) Transformation Project[22] was an interaction design project that moved beyond the

22 The DMM Transformation Project (2001–2005) was a research project in the Carnegie Mellon School of Design that was funded by the U.S. Postal Service from 2001 to 2005 (Richard Buchanan, project director; Angela Meyer, project manager).

traditional information design approach. Similar to the Australian Tax System Design Project,[23] the DMM Transformation Project focused on designing the information system with a long-term goal of encouraging organizational change in the U.S. Postal Service (USPS).

The DMM is a manual of more than 1,000 pages that contains all the mailing standards in the United States. It serves as the operational core of a federal agency that employs 800,000 postal workers and supports an industry of more than nine million people. However, because it was difficult to use, unnessecarily complex, and structurally inaccessible, this manual failed to provide employees and customers with the tools to understand mailing options or any guidance for making informed decisions. Therefore, designing the information architecture became the most important concern, especially because the scope of the project did not include changing the actual wording of the regulations.

Designers noted a big discrepancy between the existing topic-based structure and the way users make decisions, so that "understanding the relationships of the information contained in the DMM was the key to creating a structure that properly reflected the connections and dependencies within the document."[24] Consequently, a human-centered design approach became the fundamental principle that guided multiple goals at different design stages. During the restructuring of the architecture, numerous system diagrams were created to serve various goals. To demonstrate how the four kinds of relationships previously discussed can be used in a design project, this paper now analyzes four specific cases of system diagrams in the DMM Transformation Project.

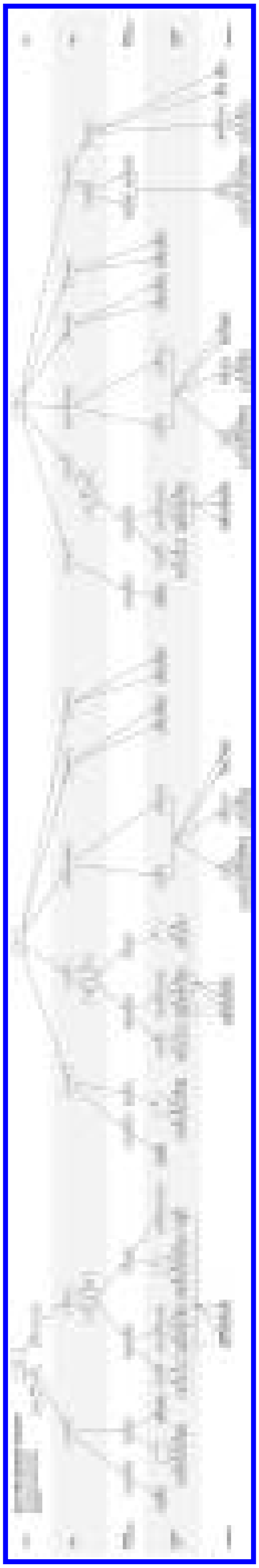
Structure Diagram

One of the fundamental goals of the DMM Transformation Project was to design a new system architecture that would improve efficiency of use. Also needed was a resilient system that could evolve over time. During the initial stages of the project, while working closely with content experts at the USPS, designers continuously analyzed, tested, and restructured the contents in different versions to ensure that the structural details were accurate. Different system diagrams were generated in this process both to analyze the existing structure (Figure 11) and to represent the changing architecture. Therefore, a system diagram was needed that focused on a simple and universal hierarchy to be used as a basic reference point for the ongoing conversation.

After the redesign of the architecture, the team collaborated to fit the content into the new structure. The Adobe Framemaker application was introduced because concerns were raised about supporting and managing a document with such a complex cross-reference. In addition, regulations would inevitably need to be updated over time, resulting in a need to change the document.

23 According to John Body, "In the ATO, the new design approach is about applying the discipline of design emerging from graphic and industrial design schools to the design of interactions with tax products and services, and to the design of the whole tax system" (Body, 2008. 57). For greater detail on this project, see Alan Preston, "Designing the Australian Tax System," in *Managing as Designing,* Richard Boland and Fred Collopy, eds. (Stanford: Stanford University Press, 2004), 208–13, and see John Body, "Design in the Australian Taxation Office," *Design Issues* 24:1, (Winter 2008): 55–67.

24 Carnegie Mellon School of Design and the United States Postal Service, *The Domestic Mail Manual Transformation Project Process Book* (unpublished, 2005), 6.



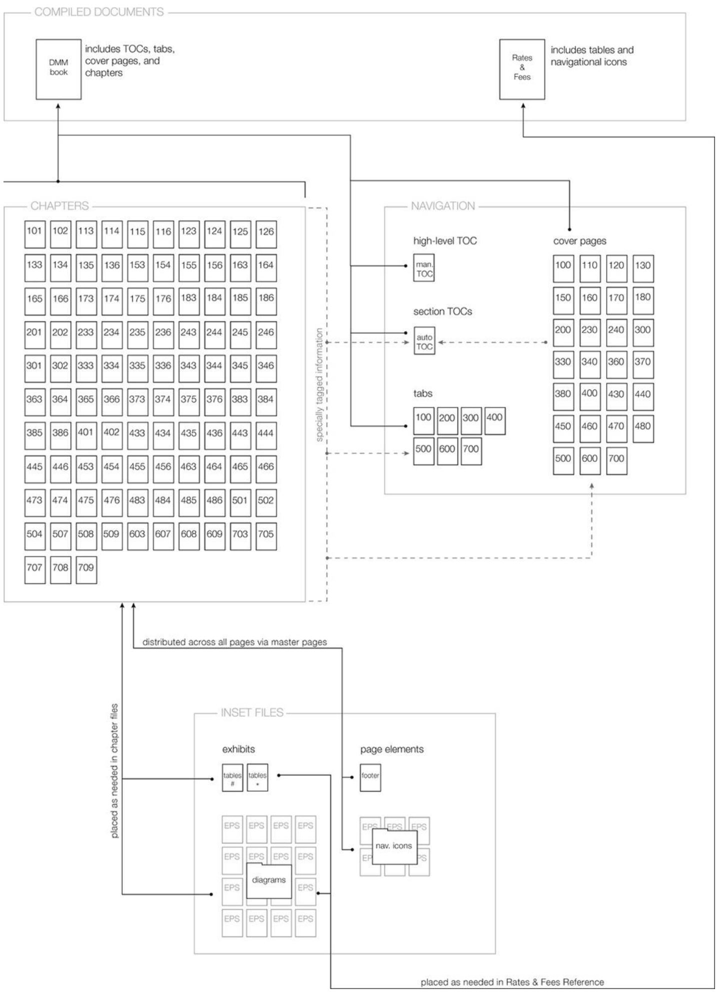


Figure 11 (left)
Rate structure analysis diagram

Figure 12 (right)
Framemaker file structure diagram

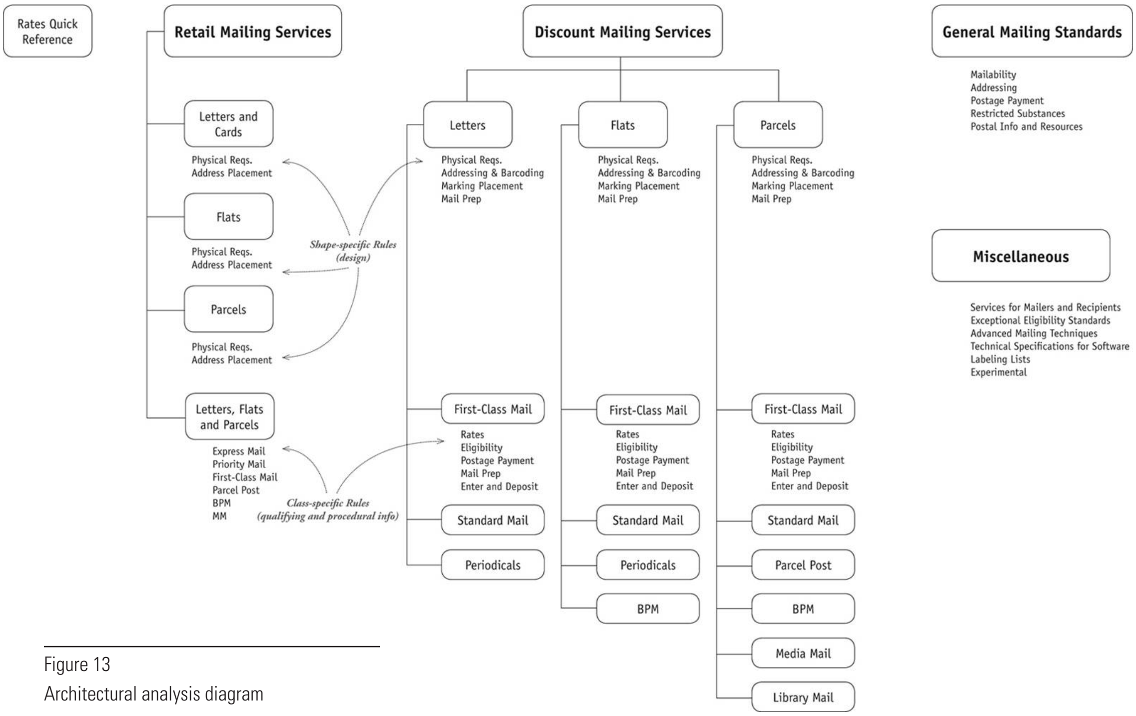


Figure 13
Architectural analysis diagram

The solution was to create a working system for the manual's ongoing editing and publication, including software, content, code, and maintenance guidelines, that would allow the USPS to continue to develop the DMM. Figure 12 is a diagram of the publishing workflow of the DMM, which was prepared as part of the maintenance guidelines. The major relationship depends on the analytical representation of how computer files are cross-referenced. While the content in Figure 12 does not differ much from that in Figure 13 (which focuses on architectural analysis), the need and purpose has changed, resulting in a changed relationship. Whereas Figure 12 focuses more on the hierarchy of regulation numbers, Figure 13 focuses on the hierarchy of shape-class-topic.[25]

Pathway Diagram

Another important goal of the project was "to develop user pathways to help customers find the information that they need in the DMM."[26] To guide users in making informed decisions, the pathway diagram (Figure 14) was based on the idea of intuitive user pathways: individual pathways are structured following the logic of decision making based on a series of questions that a user might ask when trying to decide *whether* and *how* to use the postal service; for instance, "the *issue* of shape" answers the question, "what are you mailing?"[27, 28]

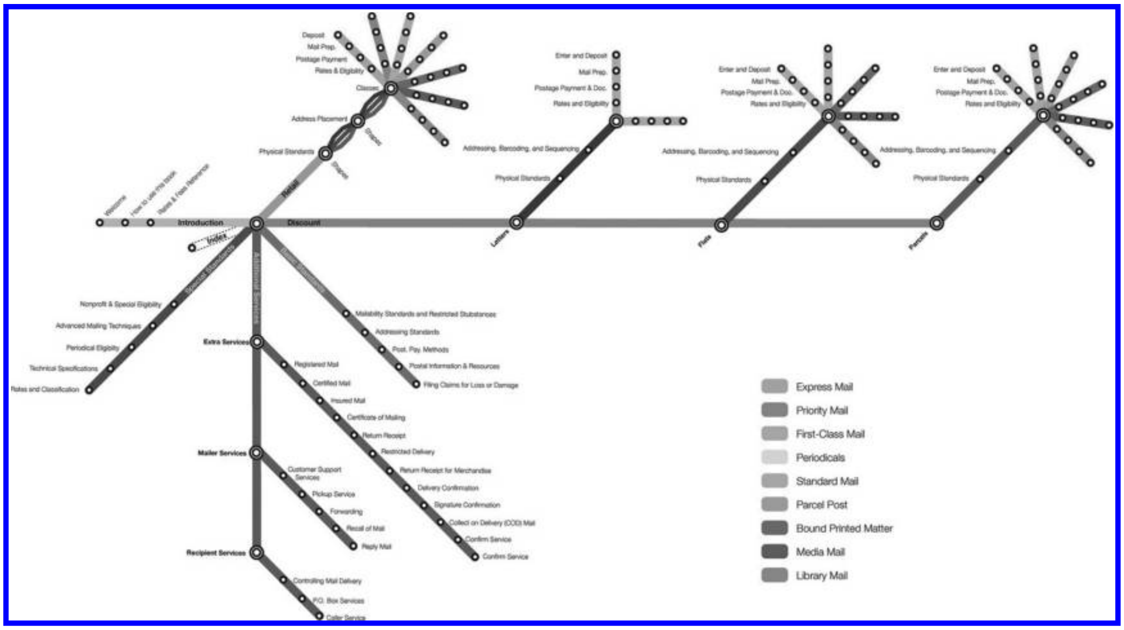
The prominent feature in a pathway diagram (Figure 14) is the connections made by lines with multiple cross-sections that lead to a certain destination, just like a subway map would. This particular

25 Research showed that users expected multiple layers of organization in the structure based on the logic of mailing procedures—first by shape, then by class, then by topic. This finding was reflected in the structure of the new DMM.

26 Carnegie Mellon School of Design and the U.S. Postal Service, *The Domestic Mail Manual Transformation Project Process Book* (unpublished, 2005), 23.

27 Ibid, 6.

28 The shape refers to "the shape of the mailpiece," such as letters, flats, and parcels.



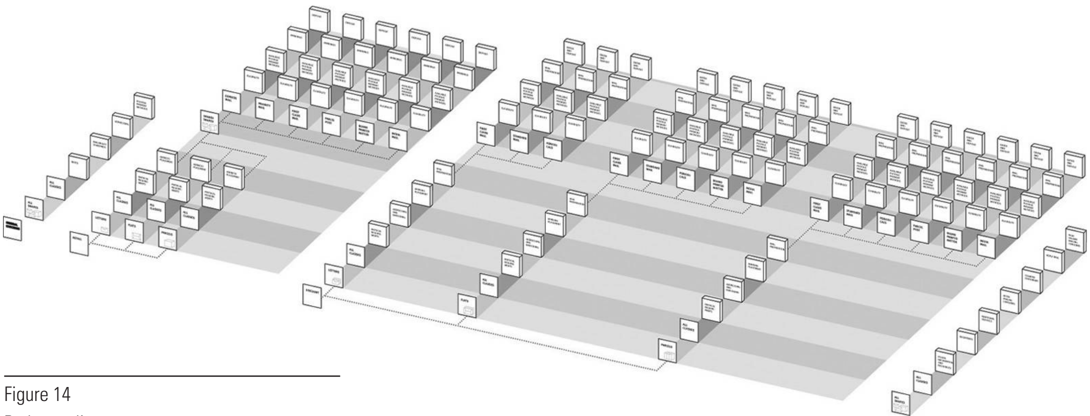
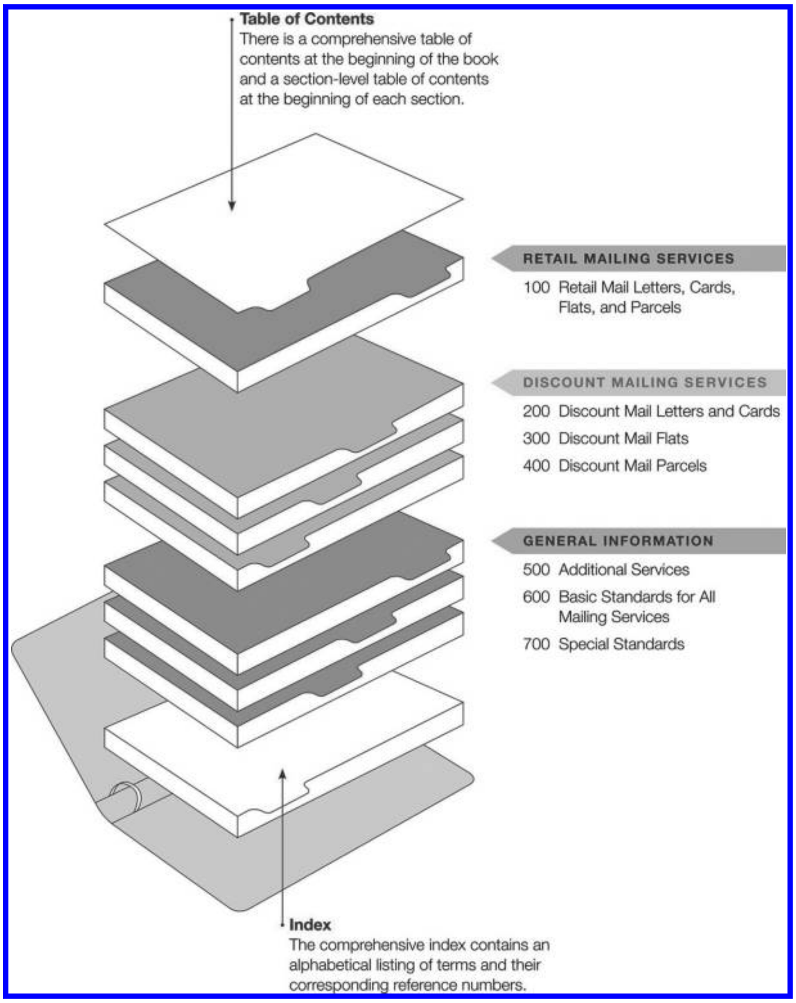


Figure 14
Pathway diagram

Figure 15
Previous iteration of Pathway diagram

form was appropriate not only to highlight the concept of pathways but also to use two major aspects that this specific system diagram features. First, a pathway diagram makes procedures apparent so that the connections between modules are recognized as navigable pathways. When transitioning from the phase of redesigning the new information architecture to the phase of fitting the content into the new structure and of making detailed adjustments, a system diagram different from the ones developed in the prior phase was needed. A new diagram was created to communicate the proposed design to the team. Second, this diagram was used to manage process and tasks. When the existing structure of the DMM was deconstructed to fit the content into the new one, this new diagram was used to visualize and check the progress as each module was completed.

Figure 16
Organization diagram



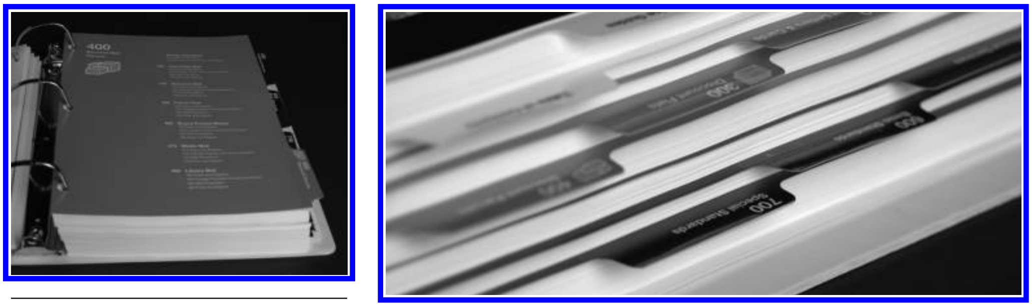
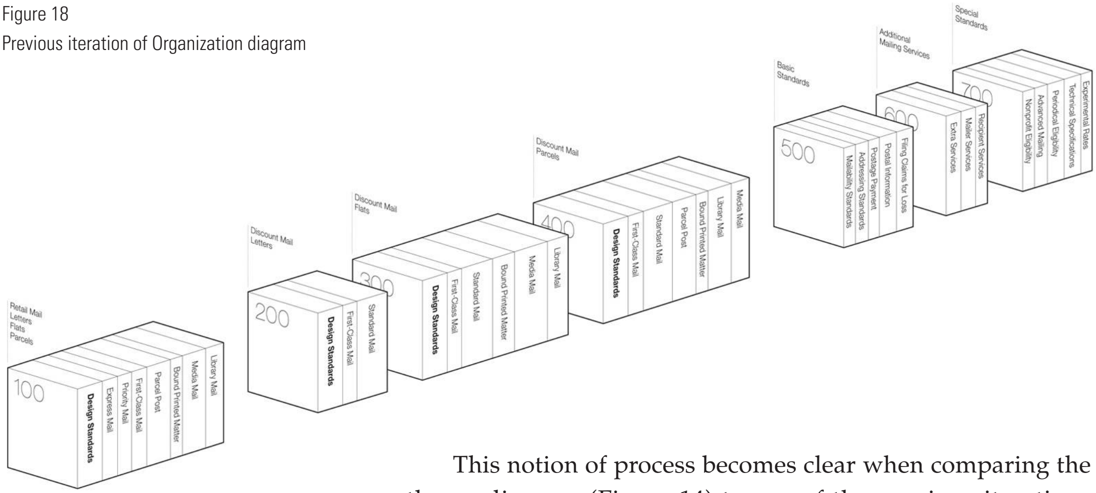


Figure 17
New DMM's color-coded divider tabs

Figure 18
Previous iteration of Organization diagram

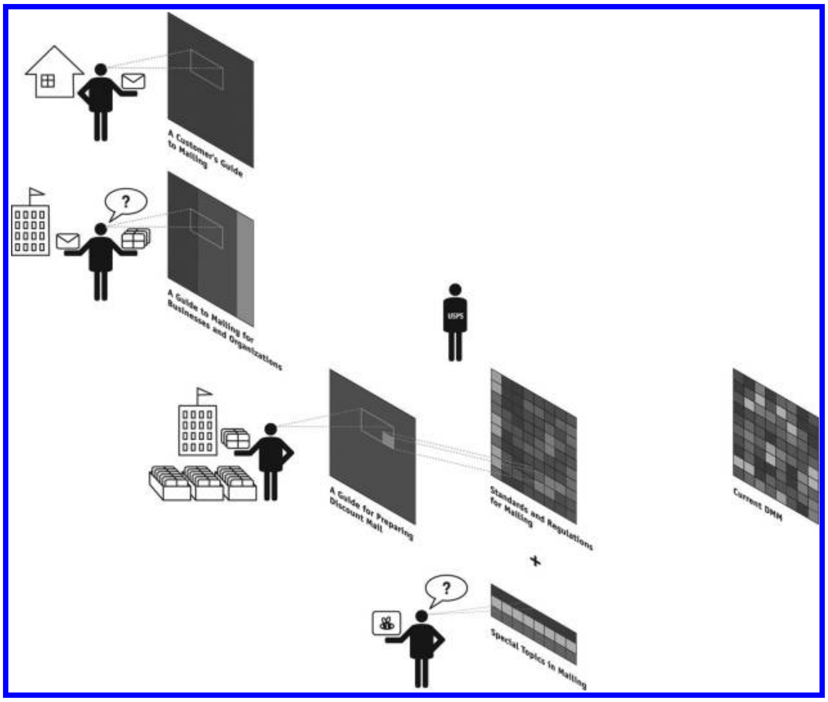


This notion of process becomes clear when comparing the pathway diagram (Figure 14) to one of the previous iterations developed for the same purpose (Figure 15). There are positive aspects in Figure 15; for instance, each module amount and the regulation numbers are more visible. However, that visibility was not the primary relationship Figure 15 needed to illustrate. In addition, the concept of navigable pathways that guide a decision-making process was not made apparent in this diagram. Lastly, representing each module in the shape of a book seemed to emphasize the materiality of documents rather than the connections between the modules. In a way, the organizing principle in Figure 15 is closer to a static hierarchical organization for structure diagrams than to a dynamic, navigable sequence.

Affordance Diagram

Another goal of the DMM Transformation Project was to create a document that is intuitively meaningful to the user. Achieving this goal entails using an information system that presents the standards from a user-perspective and that can serve pragmatic needs. After completing the restructuring of the architecture and inserting the content, the designers needed to prepare introductory material for the users. The material was not simply serving as a preface or table of contents—it was conceived to do more than just help a user locate information. First, as the old DMM evolved into the new DMM, users would need a quick and easy explanation that helped them understand the differences between the two and showed them how to use the new DMM. The introductory text also had to serve as a promotional piece that would encourage USPS employees to embrace the new document and to educate themselves about its use.

Figure 16 is the core system diagram that illustrates the document structure of the new DMM. Here, *affordance* is the key organizing principle; the diagram structure is based on the user-centered approach that accommodates users' needs, creating a satisfying user experience by providing intuitive access and a seamless transition. This goal is articulated in the DMM process



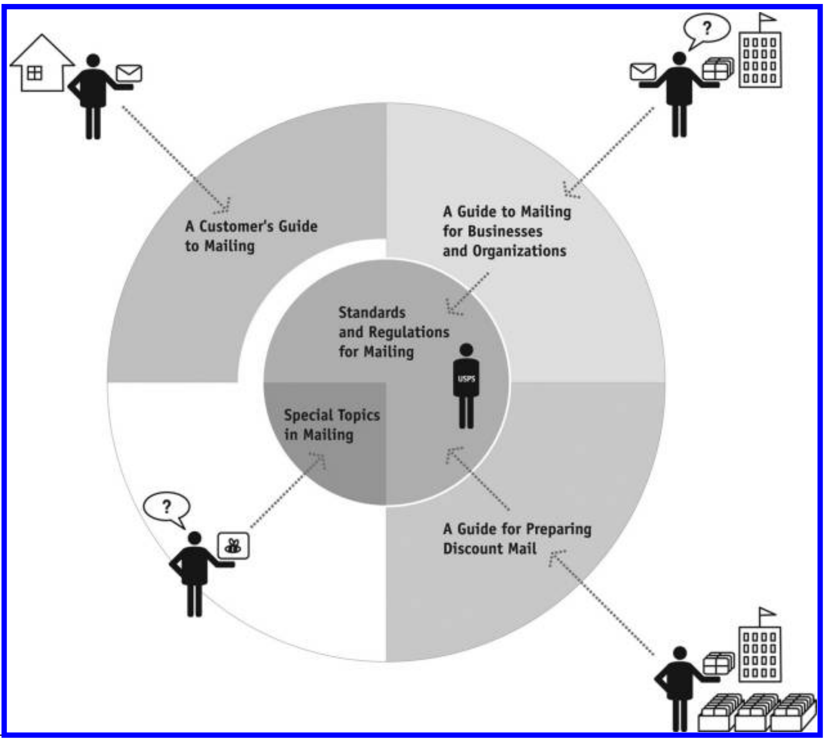


Figure 19
Shape-based framework diagram

Figure 20
User segmentation and access diagram

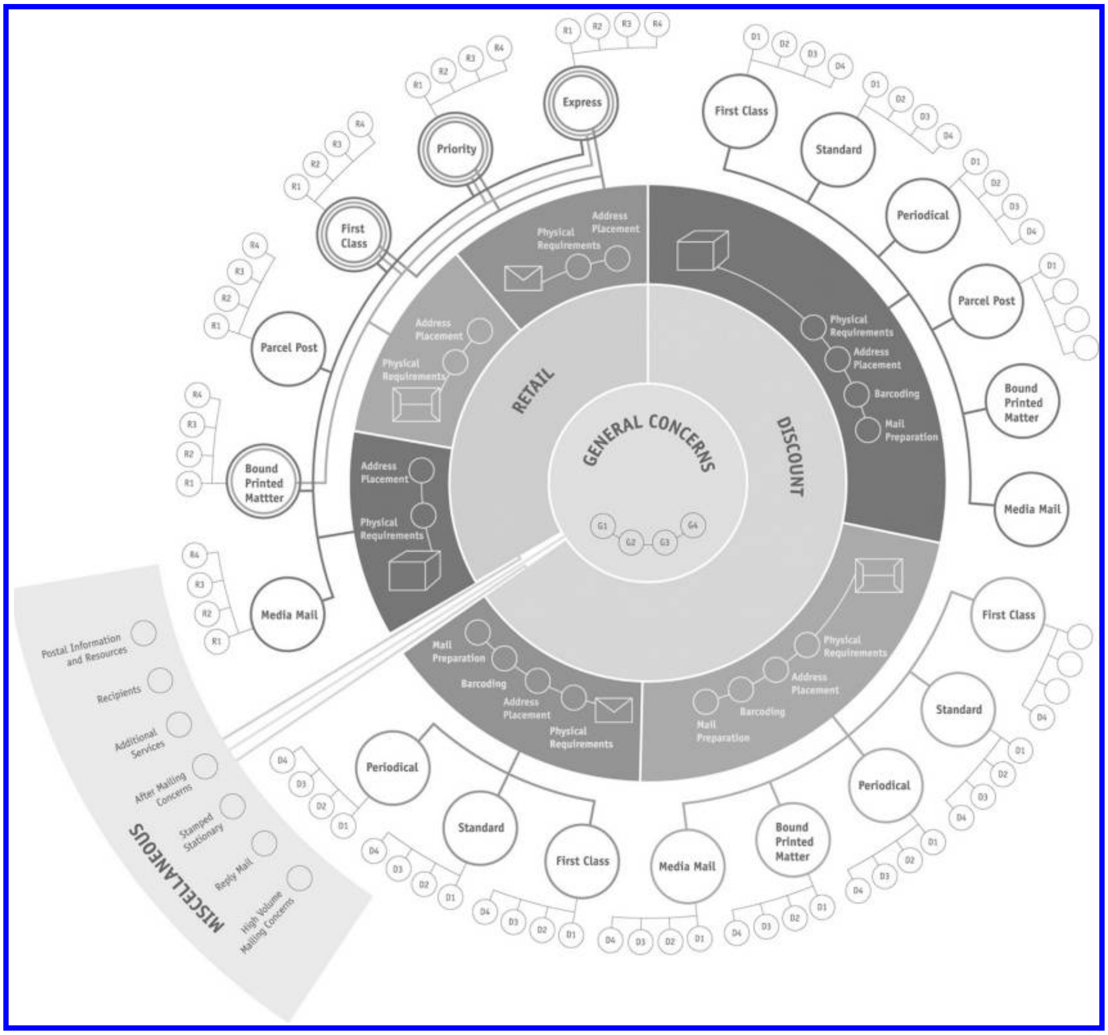


Figure 21
Architectural overview diagram

book: "good document architecture does more than just provide categories and arrangements for content. It is designed to create affordances for good user experience and is closely informed by users' real needs and expectations."[29]

Figure 16 is an example of where this relationship of affordance is realized. First, it is demonstrated by the way the new DMM is physically represented. In contrast to other schematic system diagrams, this one imitates the physical aspect of the new DMM, including the color-coded divider tabs for each section or the binder for the entire volume (Figure 17). The idea of a modular approach is similarly appropriate for best meeting a user's needs by allowing for modification of the document. Second, the use of perspective implicitly reinforces this relationship of affordance, in particular by presenting the new DMM opened and ready for use, reflecting the user's point of view. To use the new DMM, the first step is to assemble all the documents into a binder for personalization. This system diagram affords the user's possibilities

29 Carnegie Mellon School of Design and the U.S. Postal Service, *The Domestic Mail Manual Transformation Project Process Book* (unpublished, 2005), 6.

for action in determining how to assemble this document: it does not directly instruct but; rather indirectly provides one of the major entry points for document navigation. This organizing principle becomes evident when comparing Figure 16 to another iteration (Figure 18). To some degree, Figure 18 may be a more realistic representation of the volumes in that it illustrates the hierarchy of the thickness of each module. However, this detailed description is not important in the context of user action, rendering such information both unnecessary and not particularly helpful.

Vision Diagram

There were specific reasons for the project to encourage a shared vision: first, it was an academic project where, every year, a new flock of students had to quickly and efficiently assimilate into the project. It was important that the new students comprehend the project's long-term goals. Second, the work itself was complex and fragmented because there were multiple components being developed by different members, and the interweaving of task items required a holistic approach. A clear vision was needed in this process to allow the project to evolve as a whole.

The DMM process book features a clear and straightforward vision statement: "the project will design a Domestic Mail Manual that speaks directly to users and tries to meet their needs in the clearest and most efficient ways."[30] This vision of human-centered design remained the fundamental principle that drove the development of the process, unified diverse people within the USPS system, and facilitated participation in the culture of change. In other words, the project's human-centered approach was not only about the interaction between the user and the document; rather, it was about the culture of the organization that included internal users, postal employees, and even those responsible for establishing and enforcing regulations. Therefore, it was necessary to share the vision of human-centeredness with the client and with team members. At the time, this vision was ambiguous yet novel, even to the designers who joined the team. As a result, system diagrams played a critical role in embodying this abstract idea in a visible form to promote its acceptance.

Figures 19 and 20 are examples of system diagrams created for this purpose. Both were made in the early phase of the project and were posted on the wall of the studio as roadmaps to maintain the team's vision. With a rich use of symbols that effectively show the perspective and action of users, these diagrams tell the story of using the DMM for mailing as a whole. In comparison, Figure 21, which served as the inspirational figure for the project, was developed in a later phase, when the need to share the vision with the client emerged. After proposing the initial architecture, it was important to prove that the new shape-based structure would be usable by providing the clients with the first glimpse of what the

30 Ibid, 23.

new DMM would be. The comprehensive nature of Figure 21 helped bring to clients' attention the high-level organizing principle of "user-intuitive shape" without any unnecessary details. At the same time, by focusing on the relationship of holistic unity, this diagram sucessfully ensured the client that every piece of information had a logical place within the system.

Conclusion

In this article, we've identified four modes of thinking that differentiate a variety of relationships. The intent in doing so is to help clarify the organizing principles of system diagrams. However, the purpose of this research was not to place any value claims on the relationships; to be clear, one relationship is no better than another. Recognizing that all relationships are valuable advances the discussion of system diagrams in design and in related disciplines. Better understanding the essence of a system diagram can lead to a shift in perspective—from seeing it as merely a data-rich statistical graphic to conceiving it as a place for invention or discovery.

The uses for system diagrams are shifting. The emergence of complex information systems, human-centered design, and participatory culture point to a further situational change in how system diagrams will be used, as illustrated by the case study examined in this paper. To take action, users need to understand the organizing principle of complex information systems. As the problems of design become more complex, designers increasingly face the need to work in collaboration with experts from other fields, to bring in clients or users to participate in the design process, and to mediate the collaborative work of these different stakeholders. There is a growing need for a system diagram that can work as a reliable reference tool and a shared structure to support group work in such a situation, where multiple stakeholders are engaged.

This situation calls for high-level thinking that helps designers foster different modes of thought in design reasoning, while simultaneously serving as a reference point that guides designers' reflective arguments. This research contributes to design education and practice by broadening designers' understanding of the nature of systems, classifying system diagrams used in the design process according to their purpose, and exploring their potential use for supporting users' action and shared group vision.